Santa Margarita Watershed Management Area Analysis

October 2018

Murrieta Creek downstream of 1st Street

Prepared by the Santa Margarita
Watershed Management Area
Co-Permittees

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1 Introduction

1.1 Background

On May 8, 2013 the California Regional Water Quality Control Board, San Diego Region (San Diego Water Board) adopted Order No. R9-2013-0001; NPDES No. CAS 0109266, National Pollutant Discharge Elimination System (NPDES) Permit and Waste Discharge Requirements for Discharges from the Municipal Separate Storm Sewer Systems (MS4s) Draining the Watersheds within the San Diego Region (Regional MS4 Permit). Order No. R9-2015-0001 extended the permit to Orange County Region 9 Co-Permittees on February 11, 2015 and Order No. R9-2015-0100 extended the permit to Riverside County Region 9 Co-Permittees. The Regional MS4 Permit, which became effective on June 27, 2013, replaces the previous MS4 Permits that covered portions of the Counties of San Diego, Orange, and Riverside within the San Diego Region. There were two main goals for the Regional MS4 Permit:

- To have more consistent implementation, as well as improve inter-agency communication (particularly in the case of watersheds that cross jurisdictional boundaries), and minimize resources spent on the permit renewal process.
- To establish requirements that focused on the achievement of water quality improvement goals and outcomes rather than completing specific actions, thereby giving the Co-Permittees more control over how their water quality programs are implemented.

To achieve the second goal, the Regional MS4 Permit requires that a Water Quality Improvement Plan (WQIP) be developed for each Watershed Management Area (WMA) within the San Diego Region. As part of the development of WQIPs, the Regional MS4 Permit provides Co-Permittees an option to perform a Watershed Management Area Analysis (WMAA) through which watershed-specific requirements for structural BMP implementation for Priority Development Projects can be developed for each WMA. This report presents the Co-Permittees' approach and results for the regional elements of the WMAA developed for the Santa Margarita River within the San Diego County area and the results of additional analysis that was developed for the Middle and Upper Santa Margarita River Watershed within the Riverside County area.

This Santa Margarita WMAA builds upon the work completed in the 2015 San Diego County Regional WMAA (Geosyntec Consultants and Rick Engineering Company, 2015). The regional analysis developed the tools for the Santa Margarita Region (SMR) Watershed Management Area (WMA) and began the mapping effort in the lower SMR. Figure 1-1 shows and overall map of the SMR. San Diego County's mapping elements can be found in the 2015 San Diego County Regional WMAA located in Attachment I.

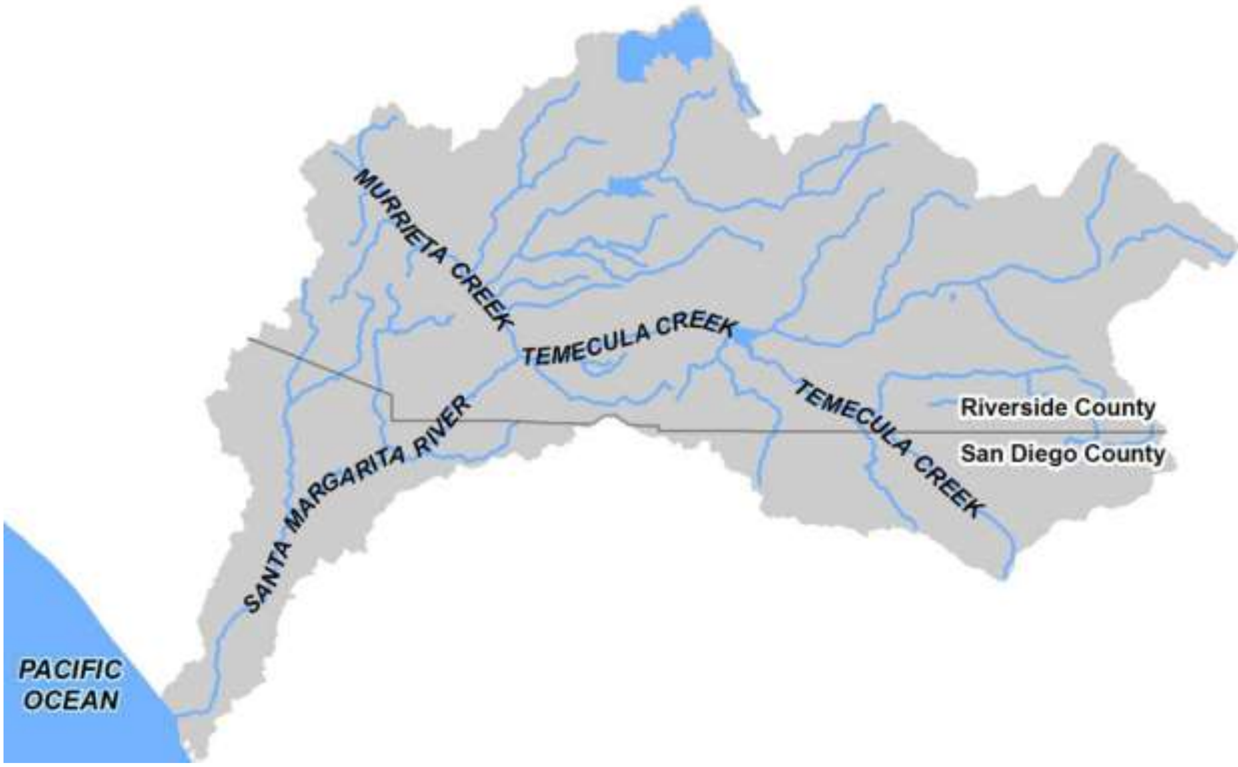


Figure 1-1. Santa Margarita River Watershed Management Area

1.2 Watershed Management Area Analysis

The Regional MS4 Permit, through inclusion of the WMAA, provides an optional pathway for Co-Permittees to develop an integrated approach for their land development programs by promoting evaluation of multiple strategies for water quality improvement and development of watershed-scale solutions for improving overall water quality in the watershed. The WMAA comprises the following three components as indicated in the Regional MS4 Permit:

- Perform analysis and develop Geographic Information System (GIS) layers (maps) by gathering information pertaining to the physical characteristics of the WMA (referred to herein as WMA Characterization). This includes, for example, identifying potential areas of coarse sediment supply, present and anticipated future land uses, and locations of physical structures within receiving streams and upland areas that affect the watershed hydrology (such as bridges, culverts, and flood management basins).
- Additionally, using the WMA Characterization maps, identify areas within the watershed management area where it is appropriate to allow for exemptions from hydromodification management requirements that are in addition to those already allowed by the Regional MS4 Permit for Priority Development Projects (PDP). The Co-Permittees shall identify such cases on a watershed basis and include them in the WMAA with supporting rationale to support claims for exemptions.
- Using the WMA Characterization results, compile a list of candidate projects that could potentially be used as alternative compliance options for Priority Development Projects.

Priority Development Projects (PDPs), at the discretion of the Co-Permittees, may participate in an alternative compliance program to provide greater overall water quality benefit to the watershed management area and offset Stormwater Pollutant Control Impacts and Hydromodification Control Impacts associated with the PDP. A PDP may be allowed to utilize alternative compliance in lieu of complying with the storm water pollutant control BMP performance requirements. The PDP must mitigate for the portion of the pollutant load in the design capture volume not retained onsite. If a PDP can utilize alternative compliance, flow-thru treatment control BMPs must be implemented to treat the portion of the design capture volume that is not reliably retained onsite.

For projects to participate in an Alternative Compliance Program, the WQIP must include the optional WMAA; and Water Quality Equivalency calculations must have been accepted by the San Diego Water Board's Executive Officer. The San Diego Water Board accepted the Water Quality Equivalency Guidance Document in December 2015. Furthermore, a fee structure program is required to complete the Alternative Compliance Program.

On December 17, 2015 the California Regional Water Quality Control Board accepted the Water Quality Equivalency Guidance Document and Water Quality Equivalency Automated Calculation Worksheets (WQE Guidance Documents). The effective date of the WQE Guidance Documents is the date of the acceptance letter and serves as the single, region-wide, applicable date after which Co-Permittee-approved alternative compliance projects may begin generating credits for potential future banking, tracking, trading, and selling. The WQE Guidance Documents form the regional and technical basis to determine the water quality benefits associated with BMPs implemented as part of an alternative compliance program. Since approval of the WQE Guidance documents, the Co-Permittees have convened a Technical Advisory Group of regional stakeholders to develop a credit framework for facilitating the use of alternative compliance in those jurisdictions. The current status of the credit framework is as follows:

1. Technical working group was established in 2016 to develop an Alternative Compliance Program for the subregion and gather input from Co-Permittees and the private sector.
2. Western Riverside Council of Governments (WRCOG) met with San Diego Regional Water Quality Control Board in August 2017 to introduce the technical working group, its findings, and plan to develop program.
3. Technical working group has developed a Draft Credit System Policy Manual handbook that will provide details on eligible project type, credits, credit eligibility, bank, and roles.
4. WRCOG has sent a request to Regional Board staff to present program and details to San Diego Regional Water Quality Control Board and acquire feedback.

1.3 Scope of Work for Regional WMAA and Middle and Upper Santa Margarita River Watershed (within Riverside County)

In July 2013, the Co-Permittees elected to fund a regional effort to develop elements of the regional WMAA for the nine San Diego-area WMAs within the County of San Diego that are currently subject to the Regional MS4 Permit, which include:

- Santa Margarita River (for portion in San Diego County)

- San Luis Rey River
- Carlsbad
- San Dieguito River
- Los Peñasquitos
- Mission Bay & La Jolla Watershed
- San Diego River
- San Diego Bay
- Tijuana River (for portion in San Diego County)

The regional-level information developed is intended to provide consistency across WMAs and serve as the foundation for developing watershed-specific information for each WMA to be developed through the WQIP process. The regional effort excluded the middle and upper portion of the Santa Margarita Watershed within Riverside County. Therefore, the scope of this WMAA will combine watershed specific information from the regional effort with additional studies performed on the Middle and Upper Santa Margarita Watershed within Riverside County. The regional WMAA will be used as a guide for developing information within Riverside County. This effort included:

- Development of GIS map layers that characterize the WMA using data previously collected, readily available, and provided by the Co-permittees, including:
- Description of dominant hydrologic processes, such as areas where infiltration or overland flow likely dominates;
- Description of existing streams in the watershed, including bed material and composition, and if they are perennial or ephemeral;
- Current and anticipated future land uses;
- Potential coarse sediment yield areas;
- Locations of existing flood control structures and channel structures, such as stream armoring, constrictions, grade control structures, and hydromodification or flood management basins;
- Development of a list of candidate projects for an optional alternative compliance program; and
- Development of additional criteria and analyses to support proposed exemptions that were originally developed in the approved 2013 Santa Margarita Region Hydromodification Management Plan.

The scope of work for the Middle and Upper Santa Margarita Watershed effort and the regional effort within San Diego County excluded performing analysis within the following areas unless data was readily available, as Co-Permittees do not have jurisdiction over these areas:

1. State Lands;
2. U.S. Departments of Defense land;
3. U.S. National Forest land;
4. U.S. Department of Interior land; and
5. Tribal lands.

1.4 Report Organization

This report references the regional WMAA for San Diego County for the Lower Santa Margarita River Watershed within San Diego County. Additional supporting information has been developed for the Middle and Upper Santa Margarita River Watershed to supplement the regional WMAA and provide a complete data set that covers the entire Santa Margarita River WMA. This report is organized as follows:

- Chapter 1 provides the project background and purpose.
- Chapter 2 describes the technical basis for characterizing the WMA.
- Chapter 3 describes potential candidate projects for the Middle and Lower Santa Margarita Watershed.
- Chapter 4 summarizes the analyses performed to support reinstating select exemptions from hydromodification control requirements for PDPs.
- Chapter 5 presents the WMAA conclusions.
- Chapter 6 presents the references used for the WMAA.
- Chapter 6 presents the Glossary used for the WMAA.
- Attachments A-F presents the exhibits for watershed management area characterization within the Santa Margarita River Watershed.
- Attachment G presents the supporting information for Hydrologic Response Unit and Critical Course Sediment Yield Analysis for the Middle and Upper Santa Margarita Watershed within Riverside County.
- Attachment H presents the supporting information for Hydromodification Exemptions on Santa Margarita Rivers and Murrieta Creek.
- Attachment I provides the San Diego County Regional Watershed Management Area Analysis.
- Attachment J presents the Candidate Projects for the Middle Santa Margarita Subwatershed.

Table 1.1 summarizes the Permit sections that identify specific WMAA requirements and the corresponding sections in this WMAA that comply with the Permit.

Table 1-1. WMAA corresponding Permit requirements

Corresponding Permit Section	WMAA Section
Provision B.3.b.(4).a.i	2.1. Dominant Hydrologic Processes
Provision B.3.b.(4).a.ii **Provision B.3.b.(4).a.v**	2.2. Existing Streams in the Watershed and Locations of Existing Flood Control Structures
Provision B.3.b.(4).a.iii	2.3. Current and Anticipated Land Uses
Provision B.3.b.(4).a.v	2.4. Potential Coarse Sediment Yield Analysis
Provision B.3.b.(4).b	3. Potential Candidate Projects
Provision B.3.b.(4).c	4. Hydromodification Exempt Areas

2 Watershed Management Area Characterization

2.1 Dominant Hydrologic Processes

The Regional MS4 Permit requires that the WMAA include a description of dominant hydrologic processes, such as areas where groundwater recharge, interflow, or overland flow likely dominate (San Diego RWQCB, 2015). Figure 2-1 displays the screening level analysis used to define the hydrologic response unit (HRU) and to then associate the HRU to a final dominant hydrologic process endpoint (e.g., overland flow; interflow; or groundwater recharge). The evaluation of dominant hydrologic processes in the SMR, however, should also consider evapotranspiration (ET). ET is the quantity of water transpired by plants, retained in plant tissues, and evaporated from plant tissues and surrounding soil surfaces (Department of Water Resources, 2005). A comparison of the estimated mean annual precipitation (4 – 10 inches) with the estimated fraction of precipitation lost to ET (90 – 99%) over a thirty year timespan in the Riverside-area watersheds suggests that ET is the dominant hydrologic process (Sanford and Selnick, 2013). Therefore, theoretically, if all the annual precipitation for Riverside County watersheds remained stationary where it fell and did not infiltrate or flow downstream to receiving waterbodies, then the precipitation would be loss to ET. Rain events, however, do not remain stationary and often produce runoff in these watersheds, especially in the urbanized areas, where the topography and land cover tend to accelerate the runoff rate downstream. Furthermore, this analysis focuses on developing information and mapping to gain an understanding of the macro-scale opportunities for locating projects that take advantage of either capturing overland flow for treatment or for supplementing the groundwater regime. Therefore, this analysis is based on the methodology illustrated in Figure 2-1 and described in Technical Report 605 titled *Hydromodification Screening Tools: GIS-Based Catchment Analyses of Potential Changes in Runoff and Sediment Discharge* (Booth et al. 2010). After considering the effects of ET (see Section 2.1.4), and an intermediate category of infiltration, the predicted fate of runoff within the Santa Margarita watershed management area was evaluated based on the hydrologic process endpoints - overland flow, interflow, or groundwater recharge.

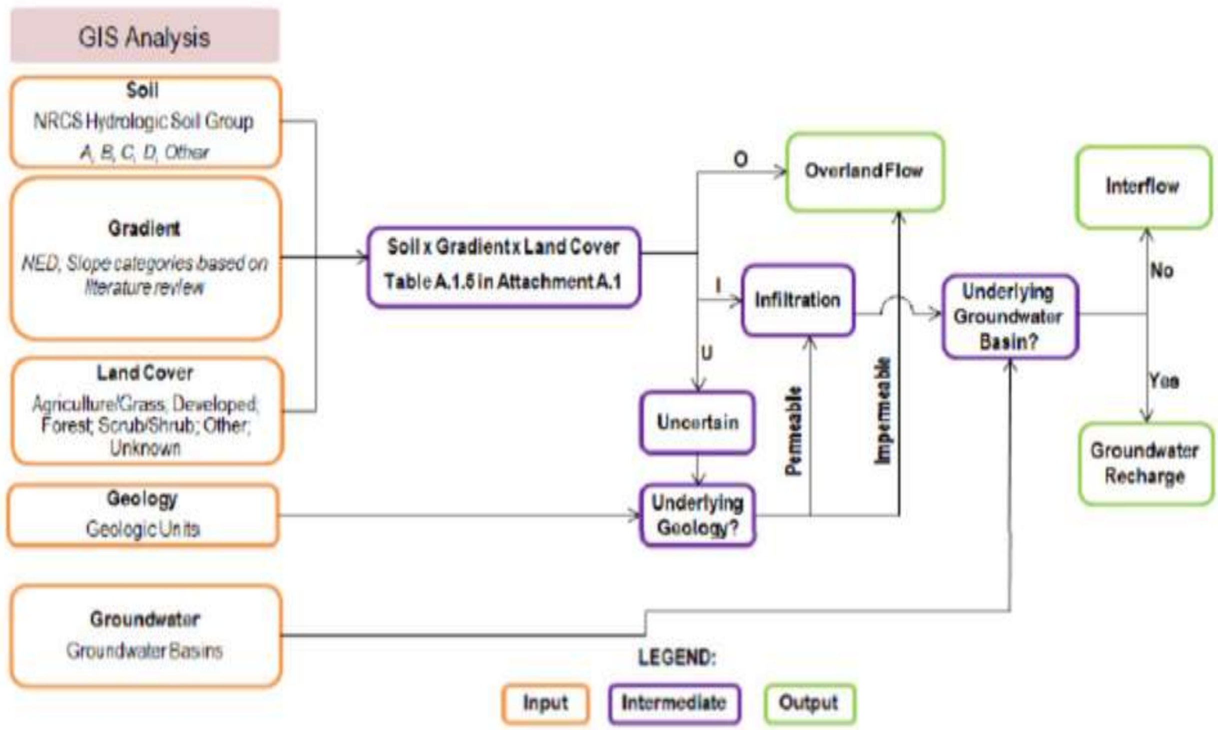


Figure 2-1. Hydrologic Response Unit and Hydrologic Process Flow Chart

2.1.1 Hydrologic Response Unit

The hydrologic process endpoint (e.g., overland flow, interflow, or groundwater recharge) was derived by first integrating soil, gradient, and land cover datasets into hydrologic response units (HRUs) using a geographic information system (GIS). HRUs are regions within a watershed which are presumed to have similar hydrologic attributes based on the combination of soil, gradient, and land cover. The GIS data acquired from public-domain sources are listed in Table 2.1.

Table 2-1. Hydrologic Response Unit Data Types and Source

GIS	Dataset	Source	Year	Description
Gradient	Elevation	USGS	2013	1/3 Arc Second (~10 meter cells) digital elevation model for San Diego County
		USGS	2016	1/3 Arc-Second digital elevation model digital elevation model for Riverside County
Soils	Hydrologic Soils Group	SanGIS	2013	NRCS (SSURGO) Database for San Diego County downloaded from SanGIS

GIS	Dataset	Source	Year	Description
		USDA/ NRCS	2017	(USDA/NRCS) Web Soil Survey and Digital General Soil Map of the United States for Riverside County https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm
Land Cover	Vegetation Type	SanGIS	2013	Ecology-Vegetation layer for San Diego County downloaded from SanGIS
		Riverside County GIS	1994	*https://gis.countyofriverside.us/arcgis_public/rest/services/OpenData/NaturalFeaturesAndHazards/MapServer/4*

Source: Geosyntec Consultants and Rick Engineering Company, 2015 and Riverside County Flood Control and Water Conservation District, 2017

Soil Categories

Soil categories were based on United States Department of Agriculture/National Resources Conservation Service (USDA/NRCS) Hydrologic Soil Group (HSG) classifications, which are commonly used to describe runoff/infiltration potential of soils on a regional scale. There are four HSGs: A, B, C, and D and three dual groups: A/D, B/D and C/D. HSGs are based on the rate of water infiltration, with Group A having the highest rates and Group D having the lowest rates. In the dual groups, the first letter is for drained areas and the second letter is for undrained areas. The following describes the methodology used to assign a single HSG rating for each of the dual groups identified in the Middle and Upper SMR Watershed.

Over two hundred polygons, equating to an area of approximately 7,000 acres in the Riverside County portion of the SMR WMA GIS were rated with a dual HSG. Dual HSG ratings were evaluated based on the mapped geologic unit as determined by published geologic mapping information, a desktop evaluation, and soils laboratory results. Specifically, the mapped geologic units were compiled into similar categories and then referenced with a geologic unit name. Geologic units were then categorized as either "coarse" or "fine" based on typical weathering characteristics for the bedrock unit or primary grain size of the sedimentary unit. For example, some geologic units weather to a coarse material such as silty sand and were therefore classified as "coarse". Geologic units that weather to a sandy clay were classified as "fine". Regarding sedimentary formations that are usually associated with variable amounts of coarse and fine units, the final classification was based on the predominating composition, i.e., sandstone/silty sand versus claystone. Finally, given that silty sands drain very quickly, any geologic unit identified as coarse was considered drained and was identified as either HSG A, B, or C. Whereas, geologic units classified as "fine" were considered undrained and were rated as HSG D in the GIS database.

HSG data were not available for some of the areas of the SMR WMA. These areas are designated as Uncertain (U) in the GIS. For HRUs considered uncertain (U), the underlying regional geology was used to evaluate whether overland flow or infiltration were dominant. This analysis was performed using GIS and is discussed further in Section 2.1.5.

Gradient Categories

The hillslope digital elevation model (DEM) for San Diego County and Riverside County was analyzed to produce a grid of slope values, which were subsequently classified into discrete categories: 0 - 2%; 2 - 6%; 6 - 10%; and greater than 10%. The greater than 10% slope category was considered the maximum limit given that slopes steeper than 10% are assumed to be dominated by overland flow. This limit is also consistent with Technical Report 605 (Booth et al. 2010).

Land Cover

Land cover categories for the Riverside County portion of the Santa Margarita WMA were defined using the ecology vegetation GIS map layers developed for Western Riverside County in the SMR (Riverside County GIS, 2014). For the San Diego County portion of the Santa Margarita watershed management area, land cover categories were defined using the Ecology Vegetation GIS map layer developed for the City of San Diego, the County of San Diego and SANDAG. This GIS map layer was downloaded from SanGIS (2013). The vegetation categories in the GIS layers were grouped to match the following land cover categories: Agriculture/Grass; Developed; Forest; Scrub/Shrub, Other and Other (Water) (see Tables A.1 and A.2, Attachment A). Land cover categories for Agriculture/Grass, Forest, Scrub/Shrub, Unknown Other and Other (Water) were then related to land use categories using Table A.3 in Attachment A. A land use category for the Developed land cover category was not determined because this land cover was assumed to have overland flow as its dominant hydrologic endpoint. Table A.4 in Attachment A displays the results showing how the land cover categories related to land use.

2.1.2 Geology and Groundwater Basins

As indicated in Figure 2-1, the intermediate process is implemented after the HRUs are defined. This process entails identifying the geologic units and groundwater basins in the Santa Margarita WMA. The GIS data acquired from public-domain sources for identifying geologic units and groundwater basins are listed in Table 2.2.

Table 2-2. Geologic Unit and Groundwater Basin Data Type and Source

GIS	Dataset	Source	Year	Description
Geologic Unit	Geology	Kennedy, M.P. and Tan, S.S.	2002	Geologic Map of the Oceanside 30'x60' Quadrangle, California, California Geological Survey, Regional Geologic Map No. 2, 1:100,000 scale for San Diego County
		Kennedy, M.P. and Tan, S.S.	2008	Geologic Map of the Oceanside 30'x60' Quadrangle, California, California Geological Survey, Regional Geologic Map No. 2, 1:100,000 scale for San Diego County
		Todd, V.R.	2004	Preliminary Geologic Map of the El Cajon 30'x60' Quadrangle, Southern California, United States Geological Survey, Southern California Aerial Mapping Project (SCAMP), Open File Report 2004-1361, 1:100,000 scale for San Diego County

GIS	Dataset	Source	Year	Description
		Jennings et al.	2010	"Geologic Map of California," California Geological Survey, Map No. 2 – Geologic Map of California, 1:750,000 scale for San Diego County
		Department of Conservation	2015	Geology layer for Riverside County, California Geological Survey, Geologic Atlas of California, Map No. 019, 1:250,000 scale, Compilation 1965. *http://www.conservation.ca.gov/cgs/information/geologic_mapping*
Groundwater Basin	Ground water Basin	SanGIS	2013	Groundwater Basins in San Diego County downloaded from SanGIS
	Ground water	Metropolitan Water District of Southern California	2007	Groundwater assessment study was used to determine the Dominant Hydrologic Process

Source: Geosyntec Consultants and Rick Engineering Company, 2015 and Riverside County Flood Control and Water Conservation District, 2017

Geologic Unit

The geology layer was categorized based on rock types, the predominant sediment size generated upon erosion, and their associated erodibility (Booth, et al., 2010). The attribution (and thus the naming) of the geology classes included the following categories:

- Coarse Bedrock (CB):
- Coarse Sedimentary Impermeable (CSI):
- Coarse Sedimentary Permeable (CSP):
- Fine Bedrock (FB):
- Fine Sedimentary Impermeable (FSI):
- Fine Sedimentary Permeable (FSP): and
- Other (O).

The underlying geology was then evaluated to determine if it was permeable or impermeable. This determination was based on a desktop evaluation using the best professional judgment of a Certified Engineering Geologist. All geologic units identified as permeable were considered to have infiltration as the hydrologic process endpoint, whereas all impermeable layers were considered to have overland flow as the hydrologic process endpoint. The Certified Engineering Geologist also performed a desktop evaluation of any HRUs that were identified as uncertain. Again, if the underlying geology was considered permeable, then these uncertain areas were presumed to be dominated by infiltration. Likewise, if the underlying geology was considered impermeable, then these uncertain areas were categorized as overland flow.

2.1.3 Groundwater Basins

For HRUs with relatively high infiltration the presence or absence of a regional groundwater basin underlying these areas determined whether the dominant hydrologic process was designated as interflow or groundwater recharge. The groundwater recharge hydrologic process was assigned as dominant for those applicable areas which have an underlying groundwater basin. The interflow hydrologic process was assigned as dominant for those applicable areas which did not have an underlying groundwater basin.

2.1.4 Hydrologic Characteristics and Evapotranspiration (ET)

For each of the land cover/land use categories the ratio of precipitation lost to evapotranspiration (i.e. an evapotranspiration coefficient) was estimated using the process described by Geosyntec Consultants and Rick Engineering Company (2015) as indicated below as Equation 1 (Eq 1). Since precipitation is the sum of the resulting runoff, infiltration, and evapotranspiration, the coefficients for these three hydrologic pathways sum to one using Equation (Eq) 1.

$$\text{Runoff Coefficient} + \text{Infiltration Coefficient} + \text{Evapotranspiration Coefficient} = 1 \quad \text{(Eq. 1)}$$

2.1.4.1 Evapotranspiration Estimate

To estimate the evapotranspiration (ET) coefficient for each land cover, the runoff coefficient was identified by evaluating the highest runoff potential for the most common storm conditions. Using this, the ET coefficient was calculated as the difference (i.e., ET Coefficient = 1 – Runoff Coefficient). The ET coefficient calculated for the highest runoff potential was then applied to all soil types and slopes within each land use category.

2.1.4.2 Infiltration Estimate

The infiltration coefficient for each applicable HRU (i.e., combination of soil, gradient, and land cover) was estimated by subtracting both the runoff coefficient, and the ET coefficient, from one (i.e., Infiltration Coefficient = 1 – Runoff Coefficient – ET Coefficient).

2.1.4.3 Runoff Estimate

For each applicable HRU, the runoff coefficient was divided by the infiltration coefficient to obtain a ratio representing the potential for runoff or infiltration. The higher the ratio, the greater the potential for runoff to be a more dominant hydrologic process than infiltration. Similarly, the lower the ratio, the greater the potential for infiltration to be a more dominant hydrologic process than runoff.

2.1.4.3.1 Associate Runoff and Infiltration HRUs

The following designations were assigned to each applicable HRU based on the runoff to infiltration ratio (i.e., runoff coefficient/infiltration coefficient). These designations were based on best engineering judgment with the underlying assumption that if a runoff or infiltration coefficient is more than 50% greater than its counterpart, then the prevailing process is considered dominant. Table A.5 in Attachment A summarizes these findings for Riverside County and San Diego County.

- HRUs with runoff to infiltration ratios greater than 1.5 (3:2 ratio) were assumed to have relatively high runoff and overland flow was considered its dominant hydrologic process. These HRUs are designated by the letter "O" (Overland flow is dominant process).

- HRUs with runoff to infiltration ratios less than 0.67 (2:3 ratio) were assumed to have relatively high infiltration and its dominant hydrologic process was either interflow or groundwater recharge, based on analysis described in subsequent steps. These HRUs are designated by the letter "I" (Interflow is dominant process) in Table A.5 of Attachment A.
- For HRUs with runoff to infiltration ratios ranging from 0.67 to 1.5, it was uncertain whether it was dominated by overland flow or infiltration. These HRUs are designated by the letter "U" (Dominant process is uncertain).
- For HRUs that have a Developed land cover or a gradient greater than 10%, the runoff to infiltration ratios were not calculated because these HRUs were assumed to have overland flow as the dominant hydrologic process. These HRUs are designated by the letter "O" (Overland flow is dominant process).

2.1.5 Uncertain HRUs

For HRUs considered uncertain (U), the underlying regional geology (Kennedy and Tan, 2002 and 2008; Todd, 2004 and Jennings et al., 2010) was used to evaluate whether overland flow or infiltration were dominant. If the underlying geology was considered impermeable, then these uncertain areas were considered to have overland flow as its dominant hydrologic process. If the underlying geology was considered permeable, then these uncertain areas were dominated by infiltration. The determination of whether a geologic unit is impermeable or permeable was based on desktop evaluation and the best professional judgment of a Certified Engineering Geologist (CEG). This analysis was performed in GIS and the results are displayed in Table A.6 of Attachment A.

2.1.6 Dominant Hydrologic Process Results

The resulting GIS map displaying the spatial distribution of dominant hydrologic processes within the Santa Margarita WMA is provided as Figure A.1 in Attachment A. Based on this analysis, overland flow is the predominant hydrologic process in the Santa Margarita watershed management area. This endpoint was verified by the Riverside Co-Permittees as part of their review process and was also found to be consistent with the experience of engineering professionals familiar with the hydrology of the County of San Diego. An exhibit summarizing the 2016-2017 public participation efforts for the SMR WMAA is provided as Table A.7 in Attachment A.

2.1.7 Limitations

This analysis identified the dominant hydrologic processes in the SMR WMA. The methodology was based on utilizing regional, public domain datasets. Although the analysis provided a useful, rapid framework to identify the dominant hydrologic processes, it was performed as a screening-level analysis. When more precise estimates are required, it is recommended that the SMR GIS be augmented with site specific analysis.

2.2 Existing Streams in the Watershed and Locations of Existing Flood Control Structures

Murrieta Creek, Temecula Creek and Santa Margarita River are the three major watercourses examined for the stream characterization. The Permit requires a description of existing streams in the watershed, including bed material and composition, and if they are perennial or ephemeral; and locations of existing flood control structures and channel structures, such as stream armoring, constrictions, grade control structures, and hydromodification or flood management basins.

2.2.1 Summary of Datasets

The following datasets were used to characterize existing streams:

- Riverside County Flood Control and Water Conservation District (District) Facilities Area – "RCFC_WCD.RCFC_FACILITIES_AREA"
- RCFC&WCD As-Built Drawings
- Riverside County 2014 Hydromodification Susceptibility Report and Mapping
- National Hydrography Dataset – Flow lines in Riverside County
- Riverside County GIS Major Hydrology – "RIVCO.MAJOR_HYDROLOGY"
- Google Earth to assist in determining category selection (categories included in Section 2.2.2.1)
- USGS National Hydrography Dataset for San Diego County, downloaded from USGS November 2013
- USGS 7.5-minute quadrangles, compiled image of quadrangles covering San Diego County, various dates
- Floodplains: "National Flood Hazard Layer," for San Diego County provided by Federal Emergency Management Agency, October 2012
- Various datasets provided by San Diego County Co-Permittees depicting existing storm water conveyance infrastructure within their jurisdictions.
- Aerial photography of San Diego County by Digital Globe dated 2012

2.2.2 Methodology

2.2.2.1 Streambed Material and Composition

The Riverside County 2014 Santa Margarita Hydromodification Susceptibility Report and Mapping (2014 HMP) categorized existing streams and channel segments based on information obtained by the Co-Permittees and the National Hydrography Dataset. The Hydromodification Mapping identified streambed material and composition based on the categories described below:

> **Engineered, Fully Hardened and Maintained (EFHM):** This category includes channel segments that are fully armored (e.g. concrete, soil cement, rock rip rap, etc.) on three sides and verified by as-built drawings, aerial photographs and/or a site visit. This category also includes channel segments with reinforced concrete pipes or boxes. The channel segments and associated armoring must be designed based on specific engineering criteria (e.g. specific storm event and duration), and maintained. Co-Permittees typically engineer the EFHM channels to completely contain the 100-year flow based on ultimate landuse conditions and remain stable under these flow conditions. Co-Permittees inspect the facilities regularly to maintain the improvements per design.
>
> **Engineered, Partially Hardened and Maintained (EPHM):** This category includes channel segments that have some armoring (e.g. concrete, soil cement, rock rip rap, turf reinforcing mats, etc.) on less than three sides, and verified through the review of as-built plans, aerial photographs

and/or a site visit. The armoring placed in the channel may include bank and/or invert lining that has been design per specific engineering criteria. The channel segment and associated armoring must also be maintained.

Engineered, Earthen and Maintained (EEM): This category includes channel segments that are not armored, however, they have been constructed to resist Hydromodification as verified through the review of as-built plans. The channel segment must also be maintained to control invasive vegetation, correct any significant localized scouring identified during routine inspections, and maintain design grades in the channel. This category is intended to include channel segments constructed for flood conveyance, which generally have a design capacity in excess of a 10-year storm event.

Not Engineered and Earthen (NEE): This category includes natural channel segments that have been modified by anthropogenic activities. These may include floodplain encroachments by development, culverts, bridges, privately owned bank and/or invert stabilization (such as rip-rap or other forms of bank protection, roads, etc.), and other man-made modifications to the channel segment that are not necessarily continuous or designed to meet any specific engineering standard, but have modified the natural hydrologic characteristics of the channel segment. The improvements may or may not be maintained.

Natural (NAT): This category includes channel segments that are in a natural state, where the geometry has not been modified. The channel segment may or may not be maintained.

This information is shown on the "Existing Stream Structures – Santa Margarita Watershed" map in Attachment C.

2.2.2.2 Stream Structure Mapping

In addition to streambed material, the attached "Existing Streams and Structures – Santa Margarita River Watershed" map includes information for locations of physical structures. Determining the location of these structures was determined through a desktop analysis utilizing Google Earth and District as-built drawings. The following categories of structures were identified:

- Bridges
- Culverts
- Dams
- Streambed Stabilizer

A Streambed Stabilizer is an energy dissipater designed to reduce velocity of flow, maintain channel grade, and protect downstream areas from erosion.

2.2.2.3 Stream Hydrography

The Permit requires the WMAA to include information, "to the extent it is available" describing whether streams in the watershed are perennial or ephemeral. However, the available USGS National Hydrography Dataset (NHD) data used to describe streams provided information for "perennial" and "intermittent" streams, but not for "ephemeral" streams. For reference, the NHD defines "ephemeral" as: "contains water only during or after a local rainstorm or heavy snowmelt." None of the stream reaches were classified as ephemeral in the NHD. Therefore, none are classified as ephemeral in this WMAA. Rather, consistent with the NHD classifications, existing streams in the watershed are described as either perennial or intermittent. This information is shown on the "Hydrographic Category – Santa Margarita River Watershed" map in Attachment D. This information was obtained from the USGS National Hydrography Dataset – Flowlines. The Flowlines dataset contains an attribute for streams called "Hydrographic Category", which is defined as the portion of the year a particular feature contains water. The definitions of these categories in the USGS NHD are:

- **Intermittent** – Contains water for only part of the year, but more than just after rainstorms and snowmelt.
- **Perennial** – Contains water throughout the year, except for infrequent periods of severe drought.

USGS NHD includes hydrographic category classification for many, but not all of the streams. To classify reaches of streams that did not already contain this data in NHD, these assumptions were made:

- The USGS NHD information for the stream hydrographic category has been used when available.
- When USGS NHD has "artificial paths" for portions of the stream, the hydrographic category of the upstream portion of the stream have been assigned to the stream unless other assumptions took precedence.
- If aerial photography shows large waterbody (lake, pond, irrigation pond, etc.) perennial has been assumed for the hydrographic category.
- For ponded areas shown on the aerial photography and if the USGS 7.5-minute quadrangles shows cross hatching for the area, intermittent has been assigned unless the upstream portion of the stream was assigned as perennial pursuant to the USGS NHD then assigned perennial for the ponded area.
- USGS has a dashed line for intermittent streams. USGS has a solid line for perennial streams. In some situations this information was used to assist in the determination of assigning perennial or intermittent to a stream.

The remaining stream reaches not classified as either perennial or intermittent are presumed to be ephemeral based on extensive field reconnaissance.

2.3 Current and Anticipated Land Uses

2.3.1 Summary of Datasets

The following datasets were referenced to meet this requirement:

- 2012 Existing Land Use - (SCAG, 2015)
- Anticipated Land Use – General Plan Land Use from Riverside County, 2015
- Anticipated Land Use – General Plan Land Use from the City of Menifee, 2010
- Anticipated Land Use – General Plan Land Use from the City of Murrieta, 2010
- Anticipated Land Use – General Plan Land Use from the City of Temecula, 2005
- Anticipated Land Use – General Plan Land Use from the City of Wildomar, 2016
- Ownership: "Parcels" dated December 2013, available from SanGIS/SANDAG
- Existing land use: "SANGIS.LANDUSE_CURRENT" dated December 2012, available from SanGIS/SANDAG (existing land use)
- Planned land use: "PLANLU" (Planned Land Use for the Series 12 Regional Growth Forecast

(2050)), dated December 2010, available from SanGIS/SANDAG

- Developable land: "DEVABLE" (Land available for potential development for the Series 12 Regional Growth Forecast), dated December 2010, available from SanGIS/SANDAG
- Redevelopment and infill areas: "REDEVINF" (Redevelopment and infill areas for the Series 12 Regional Growth Forecast), dated December 2010, available from SanGIS/SANDAG
- Floodplains: "National Flood Hazard Layer" in San Diego County provided by Federal Emergency Management Agency October 2012
- Multiple Species Conservation Program (MSCP), total of four datasets available from SanGIS/SANDAG: "MHPA_SD," dated 2012, (Multiple Habitat Planning Areas for City of San Diego); "MSCP_CN," dated 2009 (designations of the County of San Diego's Multiple Species Conservation Program South County Subregional Plan); "MSCP_EAST_DRAFT_CN," dated 2009 (draft East County MSCP Plan); and "Draft_North_County_MSCP_Version_8.0_Categories," dated 2008 (draft North County MSCP Plan)

2.3.2 Methodology

The "Current Land Use Map – Santa Margarita River Watershed" map, Attachment E, is based on the SCAG 2012 existing land use dataset, updated in February 2015. The "Anticipated Land Use Map – Santa Margarita River Watershed" map, Attachment F, is based on a compilation of General Plan Land Use data from the Co-Permittees (see 2.3.1). This analysis did not include specific land uses within Tribal lands.

2.4 Potential Coarse Sediment Yield Analysis

The Critical Coarse Sediment Yield analysis predicts the potential critical coarse sediment yield areas and is largely based on the Geomorphic Landscape Unit (GLU) methodology described by Booth et al. (2010). GLUs characterize the magnitude of sediment production from areas using three factors judged to exert the greatest influence on the variability of sediment-production rates: geology types, hillslope gradient, and land cover. The GLU layer was derived by overlaying hillslope, land cover, and geology, and then assigning a relative sediment-production rate (i.e., Low, Medium, and High) to each of the resulting categories. The relative sediment production rate was then estimated for each GLU using the Revised Universal Soil Loss Equation (RUSLE) following the method applied in the San Diego WMAA by Geosyntec Consultants and Rick Engineering Company (2015). An area that was identified as coarse bedrock (CB), coarse sedimentary impermeable (CSI) or coarse sedimentary permeable (CSP) coupled with a relative RUSLE rate of Medium was considered as a potential coarse sediment yield area. Whereas, an area that was identified as CB, CSI or CSP coupled with a relative RUSLE rate of High was considered as a potential critical coarse sediment yield area. The GLU approach plus the RUSLE equation application provided a useful, rapid framework to model sediment-delivery attributes of the SMR watershed. Potential critical coarse sediment yield analysis was performed in GIS and the analytical process is illustrated as a flowchart in Figure 2-2.

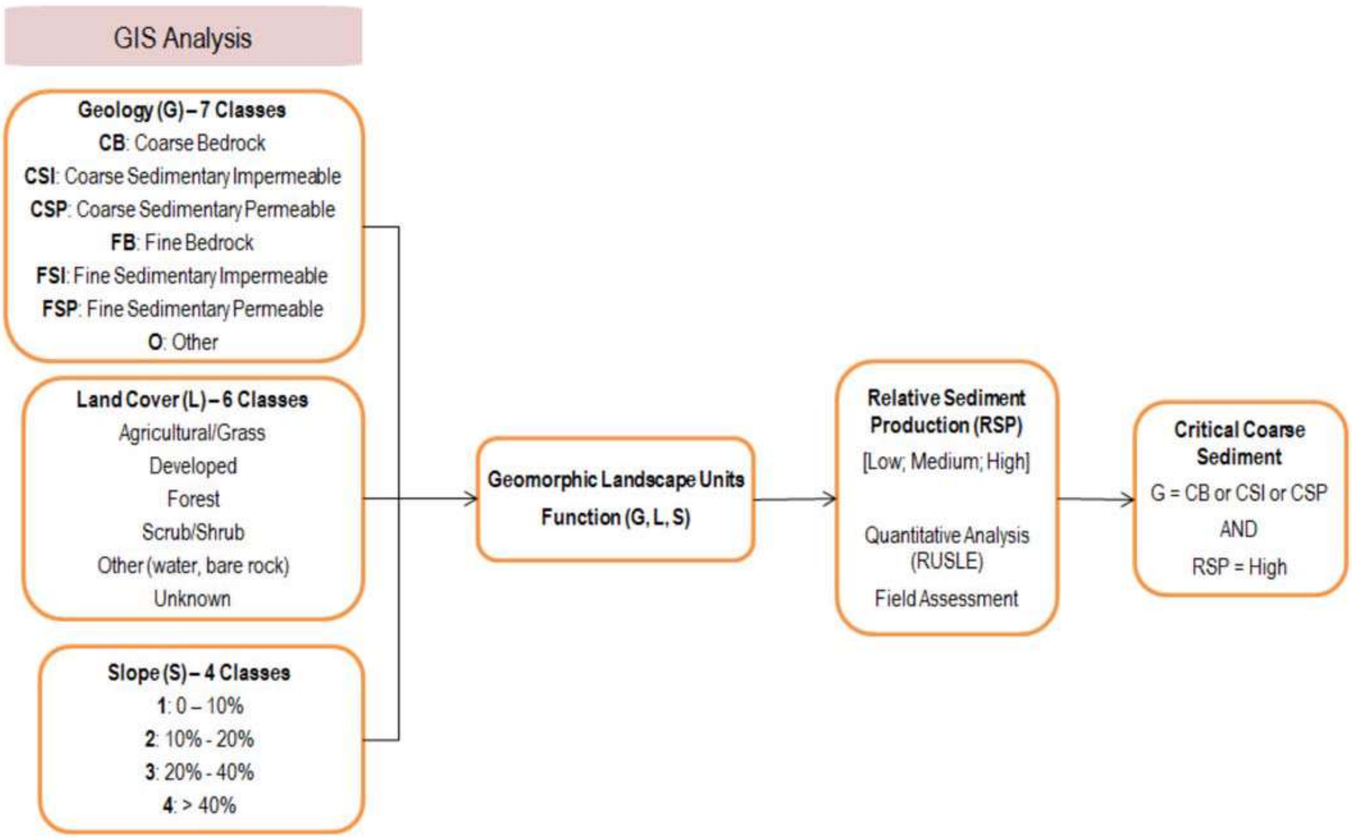


Figure 2-2. Potential Critical Coarse Sediment Field Analysis Flow Chart

2.5 Data Types and Acquisition

The geomorphic landscape unit was determined using data from the public-domain sources referenced in Table 2.3.

Table 2-3. GLU Public Domain Data Sources

GIS	Dataset	Source	Year	Description
Gradient	Elevation	USGS	2013	1/3 Arc Second (~10 meter cells) digital elevation model for San Diego County
		USGS	2016	1/3 Arc-Second digital elevation model digital elevation model for Riverside County : *https://catalog.data.gov/dataset/usgs-national-elevation-dataset-ned* *https://viewer.nationalmap.gov/basic/*
Land Cover	Vegetation Type	SanGIS	2013	Ecology-Vegetation layer for San Diego County downloaded from SanGIS
		Riverside County GIS	1994	*https://gis.countyofriverside.us/arcgis_public/rest/services /OpenData/NaturalFeaturesAndHazards/MapServer/4*
Geologic Unit	Geology	Kennedy, M.P. and Tan, S.S.	2002	Geologic Map of the Oceanside 30'x60' Quadrangle, California, California Geological Survey, Regional Geologic Map No. 2, 1:100,000 scale for San Diego County
		Kennedy, M.P. and Tan, S.S.	2008	Geologic Map of the Oceanside 30'x60' Quadrangle, California, California Geological Survey, Regional Geologic Map No. 2, 1:100,000 scale for San Diego
		Todd, V.R.	2004	Preliminary Geologic Map of the El Cajon 30'x60' Quadrangle, Southern California, United States Geological Survey, Southern California Aerial Mapping Project (SCAMP), Open File Report 2004-1361, 1:100,000 scale for San Diego County
		Jennings et al.	2010	"Geologic Map of California," California Geological Survey, Map No. 2 – Geologic Map of California, 1:750,000 scale for San Diego County
		Department of Conservation	2015	http://www.conservation.ca.gov/cgs/information/geologic_mapping

2.5.1 Geologic Categories

The geology layer was categorized based on rock types, the predominant sediment size generated upon erosion, and their associated erodibility. The attribution (and thus the naming) of the geology classes included the following categories:

- Coarse Bedrock (CB):
- Coarse Sedimentary Impermeable (CSI):
- Coarse Sedimentary Permeable (CSP);
- Fine Bedrock (FB);
- Fine Sedimentary Impermeable (FSI);
- Fine Sedimentary Permeable (FSP); and
- Other (O).

Using GIS, 35 map units were identified in the Riverside County portion Santa Margarita watershed management area and 46 map units were identified in the San Diego County portion. Table B.1 and Table B.2 in Attachment B summarize how each of the map units related to a geologic category. The geologic categories considered to have the potential to generate coarse sediment are coarse bedrock (CB); coarse sedimentary impermeable (CSI); and coarse sedimentary permeable (CSP). An exhibit displaying the geologic categories in the Santa Margarita watershed management area is presented as Figure B.1 in Attachment B.

2.5.2 Land Cover

Land cover categories were defined using the ecology vegetation GIS map layers developed for Western Riverside County for the Riverside County portion of the Santa Margarita region (Riverside County GIS, 2014). For area within San Diego County, land cover categories were defined using the Ecology Vegetation GIS map layer developed for the City of San Diego, the County of San Diego and SANDAG. The vegetation categories in the GIS layer were grouped to match the following categories: Agriculture/Grass; Developed; Forest; Scrub/Shrub, Other (Water), and Unknown.

2.5.3 Slope Classes

The hillslope DEM was analyzed to produce a grid of slope values, which were subsequently classified into discrete categories. The following category percentages were used to categorize hillslope gradients: 0 to 10%; 10 to 20%; 20 to 40%; and greater than 40%.

2.6 GLU Results

The result of evaluating geology, land cover and slope equated to 133 GLUs within the Riverside County portion of the study area and 112 GLUs within the San Diego County portion of the study area. The GIS analysis indicated that the Santa Margarita WMA is predominated by CB, CSI and CSP geologic categories and is therefore considered as an area with the potential to contribute coarse sediment. These GLUs were then evaluated to determine their relative sediment production to identify potential critical coarse sediment yield areas.

2.7 Relative Sediment Production

Relative sediment production was estimated for each GLU using the Revised Universal Soil Loss Equation (RUSLE) (see Equation 2).

A = R x K x LS x C x P (Equation 2), where

A = estimated average soil loss in tons/acre/year
R = rainfall-runoff erosivity factor
K = soil erodibility factor
LS = slope length and steepness factor
C = cover-management factor
P = support practice factor; assumed 1 for this analysis

Datasets used to estimate the average soil loss were acquired from public-domain sources as indicated below.

- RUSLE R Factor: *ftp://swrcb2a.waterboards.ca.gov/pub/swrcb/dwq/cgp/Risk/RUSLE/RUSLE_R_Factor/*[1]

[1] R-Factor database provided by Geosyntec, January 2017.

- RUSLE K Factor: State Water Resources Control Board: *ftp://swrcb2a.waterboards.ca.gov/pub/swrcb/dwq/cgp/Risk/RUSLE/RUSLE_K_Factor/*
- RUSLE LS Factor: State Water Resources Control Board: *ftp://swrcb2a.waterboards.ca.gov/pub/swrcb/dwq/cgp/Risk/RUSLE/RUSLE_LS_Factor/*
- RUSLE C Factor: US EPA, EMAP West Metric Browser: *https://archive.epa.gov/esd/archive-nerl-esd1/web/html/wemap_download.html* for the Riverside County portion of the study area and *http://www.epa.gov/esd/land-sci/emap_west_browser/pages/wemap_mm_sl_rusle_c_qt.htm#mapnav* for the San Diego portion.

GIS analysis was used to calculate the area weighted estimate of R, K, LS and C factors using the datasets listed above. For the developed land[2] cover the C factor was adjusted to 0 for the regional estimate to account for management actions implemented on developed sites (e.g., impervious surfaces). The estimated average annual soil loss ranged from 0 to 15.2 tons/acre/year in the San Diego County portion of the Santa Margarita WMA, whereas, the estimated average annual soil loss in the Riverside County area ranged from 0 to 23 tons/acre/year.

> To assess the amount of relative risk to stream channels resulting from watershed-scale changes in sediment yield and/or water delivery, the following opinions included in Technical Report 605 (Booth et al. 2010) were considered:
>
> *"The challenge in implementing this step is that presently we have insufficient basis to defensibly identify either low-risk or high-risk conditions using these metrics. For example, channels that are close to a threshold for geomorphic change may display significant morphological changes under nothing more than natural year-to-year variability in flow or sediment load.*
>
> *Acknowledging this caveat, we nonetheless anticipate that changes of less than 10% in either driver are unlikely to instigate, on their own, significant channel changes. This value is a conservative estimate of the year-to-year variability in either discharge or sediment flux that can be accommodated by a channel system in a state of dynamic equilibrium. It does not "guarantee," however, that channel change may not occur—either in response to yet modest alterations in water or sediment delivery, or because of other urbanization impacts (e.g., point discharge of runoff or the trapping of the upstream sediment flux; see Booth 1990) that are not represented with this analysis.*
>
> *In contrast, recognizing a condition of undisputed "high risk" must await broader collection of regionally relevant data. We note that >60% reductions in predicted sediment production have resulted in both minimal (McGonigle) and dramatic (Agua Hedionda) channel changes, indicating that "more data" may never provide absolute guidance. At present, we suggest using predicted watershed changes of 50% or more in either runoff (as indexed by change in impervious area) or sediment production as provisional criteria for requiring a more detailed evaluation of both the drivers and the resisting factors for channel change, regardless of other screening-level assessments. Clearly, however, only more experience with the application of such*

[2] Developed (i.e., impervious) area data layer provided by WRCOG, January 2017.

"thresholds," and the actual channel conditions that accompany them, will provide a defensible basis for setting numeric standards."

Considering the thresholds indicated above, the relative sediment production rating for each GLU followed the criterion indicated as follows:

Riverside County

Low: Soil Loss < 3.4 tons/acre/year (GLUs that have a soil loss of 0 to 3.39 tons/acre/year produce approximately 10% of the total potential coarse sediment soil loss from the Riverside County portion of the Santa Margarita WMA)

Medium: 3.4 tons/acre/year < Soil Loss < 9.55 tons/acre/year (GLUs that have a soil loss ranging from 3.40 to 9.55 tons/acre/year produce approximately 50% of the total potential coarse sediment soil loss from the Riverside County portion of the Santa Margarita WMA)

High: >9.6 tons/acre/year (GLUs that have a soil loss greater than 9.57 tons/acre/year produce approximately 40% of the total potential coarse sediment soil loss from the Riverside County portion of the Santa Margarita WMA)

San Diego County

Low: Soil Loss < 5.6 tons/acre/year (GLUs that have a soil loss of 0 to 5.6 tons/acre/year produce approximately 10% of the total potential coarse sediment soil loss from the study area)

Medium: 5.6 tons/acre/year < Soil Loss < 8.4 tons/acre/year (GLUs that have a soil loss ranging from 5.6 to 8.4 tons/acre/year)

High: >8.4 tons/acre/year (GLUs that have a soil loss greater than 8.4 tons/acre/year produce approximately 42% of the total potential coarse sediment soil loss from the study area)

2.8 Potential Critical Coarse Sediment Yield Results

Attachment B provides tables displaying GLUs that were rated as critical coarse sediment yield areas in Riverside County and San Diego County. This analysis is summarized in tabular format as Table B.3 and Table B.4, for Riverside County and San Diego County, respectively.

The resulting GIS map showing the spatial distribution of the potential critical coarse sediment yield areas within the Santa Margarita WMA is provided as Figure B.2 in Attachment B. Based on this analysis it was estimated that 28% of the of the Riverside County portion of the Santa Margarita WMA is a potential coarse sediment yield area and 9% of the study area is a potential critical coarse sediment yield area. Most of the potential critical coarse sediment yield areas were identified to be in the Scrub/ Shrub land cover areas with hillslope gradients ranging from 20 to 40%.

For the San Diego County portion of the Santa Margarita WMA, approximately 39% of the study area is a potential coarse sediment yield area and 30% of the study area is a potential critical coarse sediment yield area. Most of the potential critical coarse sediment yield areas were identified to be on slopes greater than 30%.

2.9 Limitations for Potential Critical Coarse Sediment Yield Areas

The potential critical coarse sediment yield analysis utilized regional, public domain datasets and provided a useful, rapid framework to perform a screening level analysis for the Santa Margarita WMA. This mapping effort essentially provided a high-level analysis to provide informed decision making at a regional scale. Because of the regional-scale datasets, and commensurate data resolution used to map the potential critical coarse sediment yield areas, some areas may have been mapped that do not produce critical coarse sediment as they are existing developed areas. Furthermore, the analysis did not consider instream sediment supply or fire-induced sediment production (Lave and Burbank 2004) as this was beyond the scope of a regional study. In addition, the resolution differences among the R-factor data resulted in differences in potential critical coarse sediment yield areas near the county border (see Technical Memo in Attachment B). As such, for future projects within the Santa Margarita WMA, especially along the county border, more precise data should be required by performing a site-specific analysis along with a careful interpretation of the results. The Santa Margarita WMA area GIS should then be supplemented with this site-specific data. Ultimately, the Santa Margarita WMA data for the potential critical coarse sediment yield areas should be verified in the field according to the procedures outlined in the Model BMP Design Manual and/or jurisdiction specific BMP Design Manual.

3 Potential Candidate Projects

The Permit requires Co-Permittees to use the results of the WMAA to identify and compile a list of candidate projects that Priority Development Projects could potentially use as alternative compliance options. Criteria for selecting candidate projects includes (San Diego RWQCB, 2015):

Structural Projects

1. Stream or riparian area rehabilitation; projects will restore streams to a natural, stabilized condition that can accommodate both historic and future hydromodification impacts.
2. Retrofittingexistinginfrastructuretoincorporatestormwaterretentionortreatment; projects will add or modify structural BMPs where practices do not currently exist, are ineffective, or can be significantly enhanced.
3. Regional; projects will treat stormwater, improve water quality, protect downstream channels, or reduce flooding, from a drainage area consisting of more than one development.
4. Water supply; projects will capture stormwater and infiltrate, pump or otherwise recharge groundwater, surface reservoirs, or other water supply systems.

Natural System Management Practices

5. Land Restoration; projects will restore currently developed land back to a stabilized, predevelopment condition.
6. Land Preservation; projects will prevent increases in stormwater runoff volumes and preserve floodplain function through preservation of undeveloped land.
7. Stream Rehabilitation; projects that restore a stream to a natural, stabilized condition that can accommodate both historical and future hydromodification impacts.

Potential candidate projects within the SMR are described below.

3.1 Candidate Projects for the Middle SMR Subwatershed

MEADOWVIEW STREAM RESTORATION PILOT PROJECT: The project will reduce public and water quality hazards due to existing erosion by removing vertical cut banks and restoring the natural functions of the stream using primarily soft-armoring and vegetative techniques. The project is located in the City of Temecula. This project will be a stream restoration project and be eligible for hydromodification flow control credit by providing permanent stabilization of the stream.

SANTA GERTRUDIS VALLEY- BROWNING STREET WATER QUALITY BASIN: The project will alleviate water quality concerns associated with dry weather flows at the system outfall at the northwest corner of Encanto Road, in the French Valley area in unincorporated Riverside County. This will be a regional project that improves water quality. Given the primary purpose of the project is to treat dry weather flows, it is unclear what benefit will be provided to stormwater. Coordination will continue to determine if dry weather flow treatment is eligible for stormwater pollutant control credits.

WILDOMAR MDP LATERAL C BASIN: The project will reduce flooding along Bundy Canyon Wash in the City of Wildomar. The project consists of a 19-acre footprint detention basin and outlet proposed at the southeast corner of Monte Vista Drive and Bundy Canyon Road to collect and attenuate runoff. The detention basin will incorporate water quality features to alleviate dry weather concerns in the City of Wildomar. This project will be a regional project. The project has the potential to generate both hydromodification and/or stormwater pollutant control credit depending on the final design of the facility.

COUNTY OF RIVERSIDE INTEGRATED MITIGATION PROJECT: The project is located in the French Valley area in unincorporated Riverside County and proposes to restore and enhance habitats that have been lost or degraded as a result of past agricultural and other human activities. The proposed project includes channel grading, diversion channels, check dams, habitat preservation, and habitat enhancement and creation. The project will be a stream rehabilitation project with the potential to generate hydromodification and/or stormwater pollutant control credit.

TEMECULA CREEK STREAMBED STABILIZATION: The project proposes to restore and stabilize the reach of Temecula Creek between Pechanga Parkway and Avenida Missiones, just downstream of the existing engineered channel. The project will reduce erosion susceptibility along this reach of the creek to reinstate the Temecula Creek hydromodification exemption. This will be a stream rehabilitation project with the potential to generate hydromodification credit.

MURRIETA CREEK CHANNEL FLOOD CONTROL PROJECT: The project includes construction of a 250 acre detention basin that will attenuate flows from the over 150 square mile watershed. It includes: creation of over 160 acres of wildlife habitat, development of a 50 acre regional sports park, reduction in downstream flood flow peaks, creation of regional sports park within the detention basin. This will be a regional project that will have the potential to provide hydromodification credit and stormwater pollutant control credit.

Exhibit showing approximate project location for Middle SMR Subwatershed candidate projects can be found in the Candidate Projects for the Upper SMR Subwatershed map located in Attachment J.

The projects above represent those projects planned by the District as Principal Permittee. The Co-Permittees have convened a Technical Advisory Group of regional stakeholders to develop a framework for facilitating the use of Alternative Compliance in those jurisdictions that choose to adopt an alternative compliance program. As part of these discussions, the Co-Permittees have noted that a variety of individual and programmatic actions may be taken that potentially can be credited using the adopted Water Quality Equivalency (WQE) framework (San Diego RWQCB, 2017). Such actions may include, but are not limited to, implementing stormwater runoff treatment and control measures for dirt and gravel roadways; modifying drainage and surfacing at municipal facilities to provide treatment and control of previously untreated surfaces; "over-sizing" stormwater treatment measures in conjunction with public roadway projects; and providing enhanced stormwater treatment within linear projects such as recreation pathways.

While many of these approaches would fall under the broad category of (2) above, "retrofitting existing infrastructure to incorporate storm water retention or treatment," it is not possible to identify all potential project options that may emerge over the period that this WMAA is in effect. These types of retrofits or regional projects, which have the potential to support enhanced water quality and robust implementation of Alternative Compliance, typically are identified in the course of regular planning and design processes for private development or public works projects. Therefore, the Co-Permittees emphasize that projects that are identified in the design process, and that can be credited properly in a manner consistent with the adopted WQE, are considered to be Candidate Projects for Alternative Compliance. These projects will be added to the WMAA on an annual update basis as they are identified by the Co-Permittees.

3.2 Candidate Projects for the Lower SMR Subwatershed

Analysis for the Lower SMR Subwatershed was previously conducted for the 2015 San Diego County Regional WMAA. Summaries of candidate projects within the Lower SMR Subwatershed are provided in the following sections.

3.2.1 Santa Margarita River Habitat Assessment and Enhancement Plan

The purpose of the Santa Margarita River Steelhead Habitat Assessment and Enhancement Plan is to develop a Watershed Management Area (WMA) restoration plan for the anadromous waters of the Santa Margarita River and major tributaries that emphasizes the needs of southern steelhead. The primary objective is to document existing WMA conditions, identify limiting factors to steelhead recovery, and provide prioritized solutions to address limiting factors to steelhead recovery. This objective will be accomplished through the following tasks: 1) Compile information on existing and historical conditions, including available data from studies on Camp Pendleton, and solicit input from stakeholders; 2) Conduct a WMA habitat assessment using California Department of Fish and Wildlife (CDFW) protocols that documents passage barriers and limiting habitat factors; 3) Develop prioritized recommendations for restoration opportunities and prepare a Steelhead Habitat Assessment and Enhancement Plan.

3.2.2 Santa Margarita River Fish Passage Design - Sandia Creek

A completed steelhead habitat assessment study by Cardno ENTRIX and Trout Unlimited – South Coast Chapter mapped habitat quality and fish passage barriers in detail upstream of Camp Pendleton (2013) and cited two barriers (SMR01 and SMR02) that need to be remediated in the main stem for fish passage upstream. This project has requisite engineering tasks by the WEST Consultants engineering team to arrive at design alternatives for the barriers. These include fish passage and flood flow determination, topographic survey, hydraulic analysis and fish passage evaluation, sediment transport and scour analysis, basis of design report (30-40% plans) and 65% design plans for review by relevant Co-Permittees. This project will capitalize on the opportunity for public outreach and education in this area. The project site has public access to the Santa Margarita River and to local hiking and riding trails from the nearby communities of Fallbrook and Temecula that have close regional ties to the River. The development of backcountry communities in the priority WMAs presents challenges to habitat and connectivity, and increases demand on limited water resources. This indicates a need for raising public awareness to mitigate human impact, restore ecosystems and improve water and resource management practices.

3.2.3 Fallbrook Public Utilities District Recycled Water Storage

The project would construct a recycled water storage tank that would allow for the Fallbrook Public Utility District (FPUD) to store and utilize recycled water during periods of the day when recycled demands exceed wastewater supplies. Currently, the FPUD utilizes make-up potable water to supplement the recycled water supply. Because there is currently no storage and the high demand periods occur during the day when wastewater flows are low, a large volume of make-up water is required to maintain service. It is projected that 132 acre-feet of make-up water will be used in 2010, which would be 25% of the total recycled water supply. This project would construct a below grade uncovered storage structure located adjacent to the existing equalization basin at the Water Recycling Facility. The project would be connected hydraulically to the recycled water wet well in the contact tank, which would allow utilization of stored recycled water in place of potable make-up water.

3.2.4 Implementing Nutrient Management in the Santa Margarita River Watershed - Phase I/II

The project aims to establish the science and stakeholder consensus to support the adoption of alternative nutrient Water Quality Objectives (WQOs) in the SMR WMA through the San Diego RWQCB Basin Plan triennial update. It will optimize irrigation practices by coordinating with local Resource Conservation Districts. Major tasks include: 1) facilitate SMR WMA stakeholder group to guide activities; 2) conduct monitoring and special studies to address data; 3) develop proposed nutrient WQOs for the SMR and estuary based, and 4) optimize irrigation on agricultural lands. This effort would model for the region, reduce nutrient loads and conserve water. The project leverages an investment of over $2 million contributed by WMA stakeholders since 2007.

3.2.5 Implementing Nutrient Management in the Santa Margarita River Watershed Phase III

This project aims to establish the science and seek stakeholder consensus to support the adoption of alternative nutrient Water Quality Goals (WQGs) in SMR watershed and to implement nutrient management activities. The project is the third phase of the overall project that will develop proposed nutrient WQGs for the SMR Estuary (Phase I), provide additional site-specific studies and modeling of nutrient sources and responses in the main stem of the Lower SMR River (Phase II), and in Upper SMR River and selected tributaries (Phase III) that may lead to development of nutrient site-specific objectives (SSOs) or other regulatory alternative by the SDRWQCB that are protective of beneficial uses. Nutrient management activities will include agricultural irrigation system evaluations, residential and equestrian property conservation plans and educational workshops, and will include a rebate program to encourage irrigation retrofits.

The project goals are to:

1. Maximize community involvement in SMR watershed by continued stakeholder group facilitation (established in Phase I).
2. Continue work with the group to obtain feedback and critical review of technical work products to achieve consensus on proposed WQGs.
3. Continue core monitoring and special studies to address data gaps required to develop WQGs for the SMR and tributaries.
4. Develop proposed nutrient WQGs for the SMR and tributaries, as needed, based on sound science and local data.
5. Develop proposed nutrient WQGs for selected streams in SMR watershed that are protective of beneficial uses.
6. Encourage the implementation of BMPs to reduce nutrient loading into the SMR and its tributaries.

3.2.6 Monitoring, Special Studies and Modeling will be conducted in selected SMR tributaries to further refine WQGs that are protective of beneficial uses for the SMR Watershed. Collected data and model-generated information will be used to track nutrient loads and sources, and where warranted, this data and information will be used to identify areas of the watershed where implementation of nutrient management activities would be the most beneficial. Collected data and model-generated information efforts during Phase III can be used alone or in combination with any existing data collected during Phases I and II, and any other available studies.

4 Hydromodification Exempt Areas

Hydromodification, which is caused by both altered stormwater flow and altered sediment flow regimes, can cause degradation of creeks, streams, and associated habitats. The purpose of the hydromodification management requirements in the Regional MS4 Permit is to maintain or restore more natural hydrologic flow regimes to prevent accelerated erosion and other impacts in downstream receiving waters.

In some cases, priority development projects may be exempt from hydromodification management requirements if the project site discharges runoff to receiving waters that are not susceptible to erosion (e.g., a lake, bay, or the Pacific Ocean) either directly or via an engineered facility. According to Section F.1.h.4 of the Permit. Each Co-Permittee has the discretion to exempt a priority development project from hydromodification management where the project:

(a) Discharges stormwater runoff into underground storm drains discharging directly to water storage reservoirs and lakes;

(b) Discharges stormwater runoff into conveyance channels whose bed and bank are concrete lined all the way from the point of discharge to water storage reservoirs and lakes; or

(c) Discharges stormwater runoff into other areas identified in the HMP as acceptable to not need to meet the requirements of Section F.1.h by the San Diego Water Board Executive Officer.

The June 2013 Santa Margarita Region Hydromodification Management Plan (HMP) identified certain exemptions from hydromodification management requirements by presenting "HMP Exemptions." The Regional MS4 Permit maintains some of these HMP exemptions. However, some of the exemptions are not included under the Regional MS4 Permit unless the area or receiving water is mapped in the WMAA. The intent of this section is to provide supporting technical analyses for exemptions that are recommended by the WMAA.

4.1 Additional Analysis for Hydromodification Management Exemptions

This section documents additional analysis performed to further evaluate the following exemptions (See Figure 4-1) that were approved by the San Diego Regional Board with the June 2013 Santa Margarita Region Hydromodification Management Plan. This study provides additional analysis, data, and rationale for supporting or eliminating the following existing exemptions but does not propose or study any new exemptions.

- Santa Margarita River

- Upstream Limit: At Origin, i.e. Confluence with Temecula Creek and Murrieta Creek
- Downstream Limit: Outfall to Pacific Ocean

- Temecula Creek
  - Upstream Limit: Outflow of Vail Lake
  - Downstream Limit: Confluence with Santa Margarita River
- Murrieta Creek
  - Upstream Limit: 850 feet upstream of Hawthorn Street
  - Downstream Limit: Confluence with Santa Margarita River

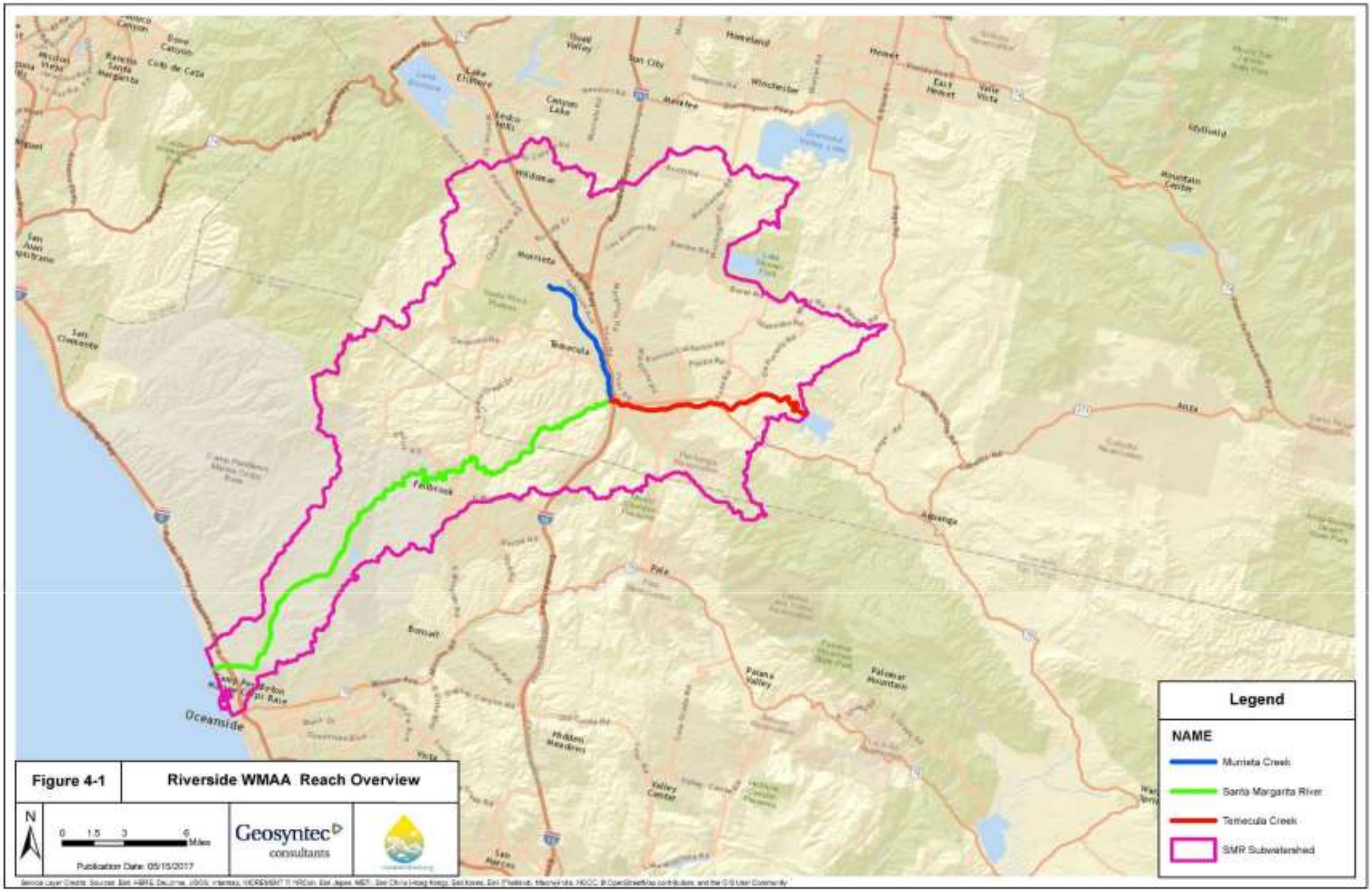
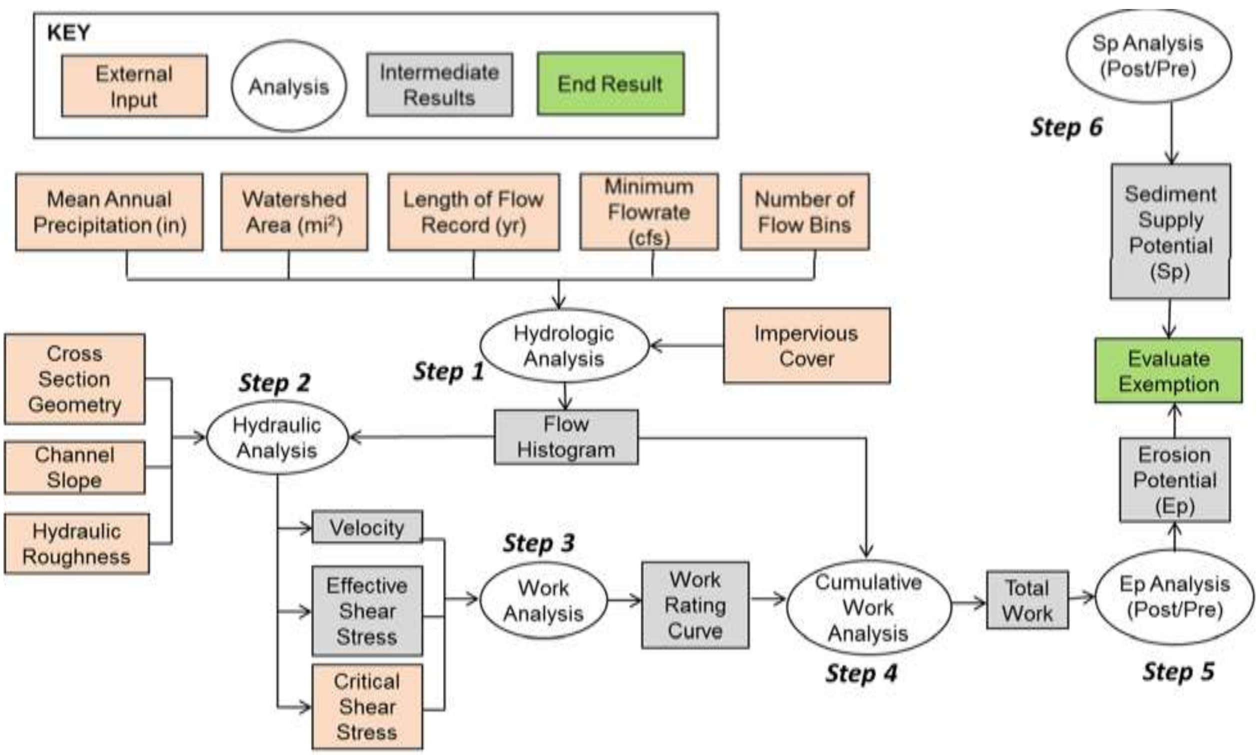


Figure 4-1. WMAA Reach Overview

4.2 Approach for Evaluating Hydromodification Management Exemptions

The approach (see diagram below) in this cumulative hydromodification impacts study accounts for: (1) hydrology, (2) channel geometry, (3) bed and bank material, and (4) sediment supply. This approach compares long-term changes in sediment transport capacity, or in-stream work, and sediment supply at specific sections of the creek for existing and future land use conditions. The ratio of future to existing condition transport capacity, or work, is termed Erosion Potential (Ep). The ratio of future/existing condition bed sediment supply is termed Sediment Supply Potential (Sp). To calculate Ep, the hydrology, channel geometry, and bed/bank materials are characterized for the existing and future conditions. To calculate Sp, the sediment supply factor is characterized for the existing and future conditions.



The findings in this study propose exemption for a given river reach if the analysis satisfies the following criteria:

- Ep < 1.05 when d50 < 16 mm or Ep < 1.20 when d50 > 16 mm, and;
- Sp > 0.5

The following bullet points provide basis for the criteria listed above:

- For Ep

  According to the Journal of Hydrology article titled Channel Enlargement in Semiarid Suburbanizing Watersheds: A Southern California Case Study (Hawley and Bledsoe, 2013): "The threshold corresponding to the presence/absence of headcutting varied based on substrate type, and was roughly quantified as a sediment-transport ratio greater than ~1.20 in systems with a median grain size > 16mm, and [Ep] ~ 1.05 when d50 < 16 mm"

- For Sp
- Technical Advisory Committee (TAC) recommendation
- County of San Diego BMP Manual Appendix H requires Sp > 0.5

According to SCCCWRP Technical Report 605, 2010, When the criteria for Ep and Sp are met, then changes in sediment supply and erosion potential are not anticipated to instigate, on their own, significant channel changes that would destabilize the stream. At present, the report suggests using predicted watershed changes of 50% or more in either runoff (as indexed by change in impervious area) or sediment production as provisional criteria for requiring a more detailed evaluation of both the drivers and the resisting factors for channel change, regardless of other screening-level assessments (SCCWRP Technical Report 605, 2010).

4.2.1 Erosion Potential Analysis

The following steps were implemented to estimate Erosion Potential (Ep):

- **Step 1** – Hydrologic Analysis
  - Due to limited flow data, a flow duration equation developed for Southern California (Hawley and Bledsoe, 2011) was used to estimate existing and future flow histograms for each watershed.
  - The change in impervious cover between existing and future development conditions was estimated using the existing and anticipated land use layer summarized in section 2.3.
    - Planning land use layers from Section 2.3 were used to estimate the existing impervious area and identify the developable parcels in each watershed. A GIS exercise was performed to identify the developable parcels in each watershed that will be exempt from hydromodification management requirements if the exemption is granted.
    - GLU analysis and its associated quantitative analysis described in Section 2.4 were used to determine Sp metric for each watershed. In this study, coarse sediment supply changes were limited to changes in hill slope erosion between existing condition and future condition (for parcels that are proposed to be exempt from hydromodification management) of the watershed. It was assumed that the changes in instream sediment supply between existing and future condition for these large depositional river systems are very minimal.
  - The process for quantifying existing vs future land use is as follows
    - Obtain and process land use data and impervious raster
      - Clip impervious raster (https://www.mrlc.gov/) to watershed boundary; Values of raster vary from 0 to 100 and represent percent impervious
      - Process land use data based on SCAG codes from 1100 to 9999
    - Perform zonal statistical analysis using ArcGIS
      - Imperviousness for each type of land use is calculated
    - Analyze results for imperviousness in each SCAG code
      - Determine total area corresponding to each SCAG code

    - Using simple average for each impervious surface coefficient associated with each SCAG code global imperviousness is calculated for each jurisdiction
  - Assumptions for percent imperviousness for each land use type were based on:
    - Office of Environmental Health Hazard Assessment (OEHHA) tool for the impervious fraction determination for areas within Riverside County.
    - The information provided in the San Diego County Imperviousness Study (County of San Diego, 2010) for areas within San Diego County.

- **Step 2** -Hydraulic Analysis
  - Critical cross section was selected for performing hydraulic analysis for each reach.
- **Step 3**: Work Analysis: The simplified effective work equation shown below is used to calculate the work done for each flow bin.
- $W = (\tau - \tau_c)^{1.5} V$

  Where
  W = Work (dimensionless)
  τ = effective Shear Stress [lb/ft^2]
  τ_c = Critical Shear Stress [lb/ft^2]
  V = Flow Velocity [ft/s]
- **Step 4**: Cumulative Work Analysis: Cumulative work is a measure of the long-term total work or sediment transport capacity performed at a given stream location. Cumulative work incorporates both discharge magnitude and flow duration distributions for the full range of simulated flow rates. Cumulative work is calculated by multiplying work and duration for each bin. Total work is calculated through summation of work from all flow bins.
- **Step 5**: Ep Analysis: Ep is calculated by dividing the total work of the future condition by that of the existing condition. The existing river reaches analyzed appear relatively stable and have not experienced excessive geomorphic instability due to the alteration of the drainage areas. Given the stable condition of the existing channels, the existing condition was used as the baseline condition instead of natural.

Steps 1 to 5 were performed in Excel. Ep estimates are included in the attachments and are summarized in a table in the corresponding section.

4.2.2 Sediment Supply Potential Analysis

- **Step 6** – Sp Analysis; Sp was estimated using the following equation; it was developed with input from Technical Advisory Committee members formed by the San Diego County Co-Permittees to develop streamlined guidance that provides applicants with simplified methods to determine impacts to coarse sediment delivery based on robust scientific principles. Sp is a metric to evaluate the changes in bed sediment supply for susceptible receiving channels of concern. Sp is directly proportional to Ep (Erosion potential). Sp has to be greater than 0.5, to substantiate a hydromodification exemption, based on current understanding of risks to receiving waters arising from changes in sediment production. Sp is estimated based on the following equation

  $Sp = 0.7*SY_{RUSLE}+0.3*SY_{NHD}$.

The hillslope coarse sediment supply (SY_{RUSLE}) was estimated using the quantitative results from Section 2.4. First, the watershed coarse sediment soil loss was estimated for all GLUs producing coarse sediment below the reservoirs in the existing condition. Then, the future-condition coarse sediment soil loss was estimated by subtracting the developed parcel below the reservoirs soil loss from the existing soil loss.

4.2.3 Criteria for Exemption

The following assessments were performed to evaluate if the projects directly discharging to the reaches discussed in Section 4.1 (see Figure 4.1) should be exempt from hydromodification management requirements. The criteria used in this analysis are consistent with the criteria approved in the San Diego Regional WMAA for determining if exemptions are appropriate, and are summarized below:

- For Flow Control:
  - Erosion potential (Ep) for the fully built-out condition compared to the existing condition shall be less than 1.20 when the median grain size (d_{50}) > 16 mm (Hawley and Bledsoe, 2013).
- For Coarse Sediment Supply:
  - Sediment supply potential (Sp) shall be greater than 0.5, based on current understanding of risks to receiving waters arising from changes in sediment production (SCCWRP Technical Report 605, 2010). Refer to the San Diego Regional WMAA report (Prepared by Geosyntec and RICK, 2015) and the San Diego Model BMP Design Manual for additional details about this criterion.

The watershed characterization maps summarized in Chapter 2 were used to evaluate the applicability of hydromodification management requirements.

4.3 Santa Margarita River

The extents of the Santa Margarita River (Upstream Limit: At Origin, i.e. Confluence with Temecula Creek and Murrieta Creek; Downstream Limit: Outfall to Pacific Ocean) for which hydromodification assessment is performed is shown in Figure 4-1. The river flows southwest through Temecula Canyon at the south end of the Santa Ana Mountains and then enters the coastal region where the river forms a large flood plain as it crosses Camp Pendleton Marine Corps Base before it enters the Pacific Ocean. The upper 15 miles of the river is characterized by a relatively narrow channel, slopes of approximately 1%, significant meanders and rocky terrain. The lower 15 miles within the coastal plain is characterized by a broader channel, shallower slopes of approximately 0.3%, and sandy substrate. Due to the two discrete channel types with varying substrate and associated particle size, two field assessments were conducted to characterize d50 and evaluate stability. Given that erosion potential (Ep) is greatest in the steepest channel, a critical section will be considered at the steepest point in the river profile. Sediment Supply (Sp) will be applied to the tributary watershed for existing and future conditions to quantify reductions in future critical course sediment supply. An additional assessment was conducted in the coastal plain to quantify the (Ep) and evaluate stability.

4.3.1 Erosion Potential Analysis

See section 4.2.1 for a description of the entire erosion potential analysis. This section includes specific information on erosion potential in the extents of the Santa Margarita River:

- The table below presents the input parameters used to construct flow histograms, as well as the estimated channel slope at the two cross sections.

Exempt River Reach	Area below the reservoirs (sq. miles)	Mean Annual Precipitation (in)	Length of Daily Flow Record (Years)	Channel Slope (ft/ft)
Upstream Santa Margarita River	352	16.3	30	0.025
Down Stream Santa Margarita River	352	16.4	30	0.003

- The upstream critical cross section along the reach for Ep analysis was selected by plotting the longitudinal profile of the reach (Figure 4-2) and selecting a cross section along the steeper portion of the channel where flow velocities would tend to be higher. A critical flow rate of 0.5Q2 was assigned to estimate the critical shear stress for the analyzed cross section.
- The downstream cross section along the reach for Ep analysis was selected based on its locations within the coastal region. The specific section investigated was selected on what could be accessed safely within Camp Pendleton. Critical shear stress for the reach was estimated based on Fischenich 2001, Stability Thresholds for Stream Restoration Materials. A value of 0.02 was assigned to estimate the critical shear stress for the analyzed cross section.

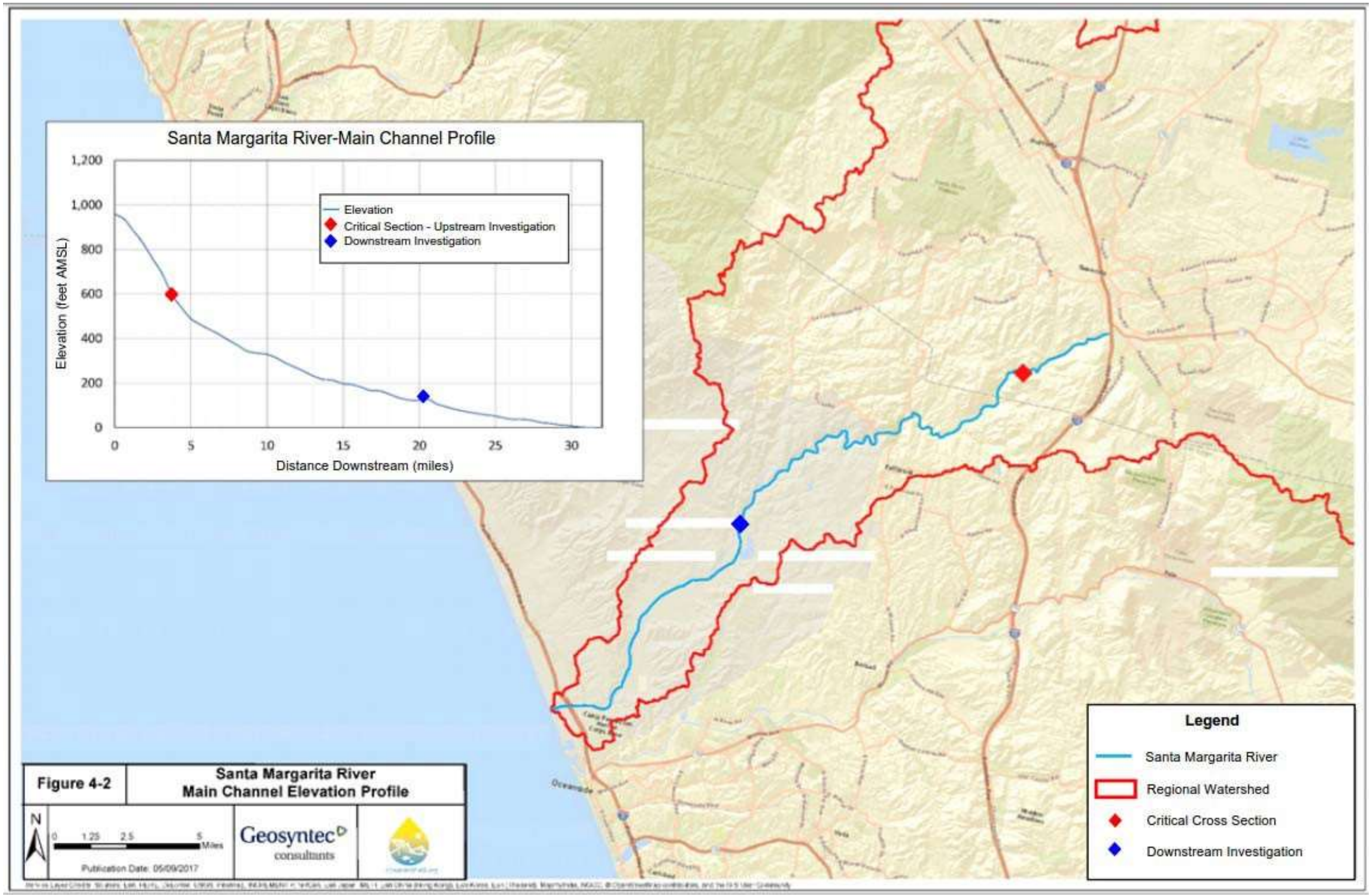


Figure 4-2. Santa Margarita River: Main Channel Elevation Profile

Upstream Investigation

- Field assessment was conducted on June 16, 2017 by Geosyntec Consultants (Geosyntec) within the vicinity of the critical cross section on the Santa Margarita River to assess channel stability and estimate the median grain size of the channel bed material. Based on the results of the field screening performed, the equivalent grain size for the reach with the critical cross section was determined to be greater than 16 mm. Representative channel and flood plain photos based on the field visit are shown in Figure 4-3 and Figure 4-4 below. As can be seen in both photos, the bed material is comprised mostly of large cobble and boulders well in excess of 128 mm. No evidence of downcutting or lateral adjustment was observed. Per SCCWRP Technical Report No. 606, the channel was determined to be consistent with a CEM Type 1 channel.
- Bed Material – Coarse/Armored Bed with boulders/cobbles, d50>128 mm
- Channel Evolution Model - CEM Type 1

Figure 4-3. Upstream Representative Channel

Figure 4-4. Upstream Representative Floodplain

Downstream Investigation

- Field assessment was conducted on March 20, 2018 by Riverside County Flood Control and Water Conservation District staff, within the downstream reach in the vicinity of Camp Pendleton on the Santa Margarita River to assess channel stability and estimate the median grain size of the channel bed material. Based on the results of the field screening performed, the equivalent grain size for the reach was determined to be greater than 16 mm. Representative channel and flood plain photos based on the field visit are shown in Figure 4-5 and Figure 4-6 below. As can be seen in both photos, the bed material is comprised mostly of sands, silts and gravel in excess of 16 mm. No evidence of downcutting or lateral adjustment was observed. Sedimentation was apparent throughout the stream bed. Per SCCWRP Technical Report No. 606, the channel was determined to be consistent with a CEM Type 1 channel.
- Bed Material – Sand and Gravel, d50>16 mm
- Channel Evolution Model - CEM Type 1

Figure 4-5. Downstream Representative Channel

Figure 4-6. Downstream Bed Material

EP estimates are included in Attachment H and are summarized in table below.

Exempt River Reach	Area below the reservoirs (Vail Lake and Skinner Reservoir) (acres)	Impervious Area (acres) [%]			Upstream Ep (Post/Pre) [Criteria <1.20]	Downstream Ep (Post/Pre) [Criteria <1.20]
		Pre	Post	Increase		
Santa Margarita River	225,505	29,772 [13.2]	40,106 [17.8]	10,334 [4.6]	1.13	1.13

The estimated Ep is smaller than the threshold value of 1.20, hence the flow control criteria for Ep is considered to be met. Ep values less than 1.2 indicate the transport capacity of instream work for pre and post conditions will not be significantly altered or lead to unstable conditions. The factor of safety = 1.13/1.20 = 0.94, or a 6-7% factor of safety.

4.3.2 Sediment Supply Potential (Sp) Analysis

Results from this calculation (see Section 4.2.2 for approach) are presented in the below table.

Exempt River Reach	Coarse Sediment Soil Loss (tons/yr.)			SY_{RUSLE}
	Pre	Developed Parcels (downstream of Reservoirs)	Post [Pre – Developed Parcels]	
Santa Margarita River	1,352,421	432,298	920,123	0.68

Disturbance to NHDPlus channels are protected through 401 water quality certifications or waste discharge requirements issued by the RWQCB, so it is assumed that SY_{NHD} =1.

$$\text{Estimated Sp} = 0.7*SY_{RUSLE}+0.3*SY_{NHD} = 0.7*0.68 + 0.3*1 = 0.78.$$

The estimated Sp is greater than 0.5 so the reach meets the sediment supply potential criteria. The value being greater than 0.5 indicate that sediment supply for pre and post conditions will not be significantly different and adequate sediment supplies to the stream will continue. The factor of safety = 0.78/0.5 = 1.56 or 56% factor of safety.

4.3.3 Recommendation

Based on the results from this study, it is recommended that hydromodification management exemption be reinstated for projects discharging runoff directly to the Santa Margarita River (Upstream Limit: At Origin, i.e. Confluence with Temecula Creek and Murrieta Creek; Downstream Limit: Outfall to Pacific Ocean).

Each municipality must define/approve "direct discharge" based on the project site conditions. To qualify for the potential exemption, the outlet elevation must be between the river bottom elevation and the 100-year flood plain elevation and properly designed energy dissipation must be provided.

The Santa Margarita River Estuary (Estuary) is on the 303(d) impairment list for eutrophic conditions. While no analysis has been performed within this assessment, the proposed exemption is not anticipated to conflict with water quality objectives in the Estuary for the following reasons.

1. Nitrogen and Phosphorus loading from the watershed will not be measurably different with or without the proposed hydromodification management exemption. The primary driver of the eutrophic conditions in the Estuary is during dry weather. The exemption has no effect on dry weather discharges or rising groundwater inputs to the Estuary in which the eutrophication symptoms are most prevalent.
2. According to the exemption analysis, this stream system is anticipated to be stable, (i.e., excessive or accelerated erosion is not expected), such that, sediments carrying nutrients would not increase downstream. Furthermore, Ep and Sp analysis indicate that channel erosion and transport will not be significantly changed and therefore instream channel derived sediment and associated nutrients are not expected to increase.
3. Water Quality Analysis Simulation Program model results, included in the Model Application Report, notes that the hydromodification controls are unlikely to have a significant impact on the Estuary. Implications of the findings is that wet weather structural BMPs, which generally cost an order of magnitude or higher to implement, may not provide any additional environmental benefits to the Estuary than implementation of dry weather BMPs alone.
4. The watershed of the Santa Margarita River downstream from the reservoirs totals 352 square miles. The area being evaluated for the proposed hydromodification exemption totals approximately 10 square miles or 2.8 % of the total watershed. Given the relatively small area in which the proposed hydromodification exemption will be applied within the greater Santa Margarita Watershed, the exemption is not expected to exacerbate eutrophic conditions.
5. Within the hydromodification exemption area, priority development projects in the absence of hydromodification requirements will still be required to provide treatment of the 85th percentile rainfall with an effective combination of BMPs that target the constituents of concern such as nitrogen and phosphorus. Additionally, all priority development projects will implement peak flow control BMPs as required by Riverside County Flood Control and Water Conservation District to preserve the 2 to 10-year peak flow rates generated by the project site. Treatment of stormwater runoff through effective BMPs combined with preservation of 2-10 year peak flow rates will ensure target pollutants such as nitrogen and phosphorus are effectively treated and the drainage response is preserved. This strategy will effectively provide a similar level of mitigation required by hydromodification.
6. Hydromodification BMPs are designed to release stored volume over an extended period which effectively increases the duration of low flows. Increasing durations will expand the wet weather

response and could contribute to dry weather flow volume, thereby contributing to dry weather flows. This could conflict with the effort to reduce dry weather input of nitrogen and phosphorus to the estuary. The proposed hydromodification exemption could serve to minimize these potential adverse impacts.

7. Other contributors such as lateral inputs and tidal exchange will not be impacted by the hydromodification exemption. The agricultural fields near the Santa Margarita River Estuary have been identified as a significant source of sediment and nutrients from erosion and subsequent sedimentation in the estuary. Additionally, lack of tidal exchange has been identified as contributing to lower levels of dissolved oxygen. These contributing factors will not be exacerbated from a hydromodification exemption.

These findings strongly support the determination that a hydromodification exemption will not contribute to further degradation of the Santa Margarita River Estuary. The condition of the estuary and the stability of the Santa Margarita River will continue to be monitored and ongoing evaluations will continue as permits are reissued to verify the river is stable.

4.4 Temecula Creek

The extents of the Temecula Creek (Upstream Limit: Outflow of Vail Lake; Downstream Limit: Confluence with Santa Margarita River) for which hydromodification assessment is performed is shown in Figure 4-5.

On September 14, 2017, a field team from Geosyntec investigated segments along Temecula Creek to assess channel stability and susceptibility to erosion, and hydromodification impacts. An initial desktop assessment of aerial maps was used to determine areas of interest showing signs of erosion or geomorphic change. Information was collected based on Hydromodification Screening Tools: Field Manual for Assessing Channel Susceptibility (Booth et al., 2010).

Although multiple locations along the creek were visited, this report is focused on the downstream reach of Temecula Creek, particularly between Pechanga Parkway, at the downstream end, and Avenida de Missiones, at the upstream end. Aerial and field photographs are presented below to highlight observed susceptibility to erosion in the Creek.

Figure 4-7.: Temecula WMAA Reach Overview

4.4.1 Temecula Creek between Pechanga Parkway and Avenida de Missiones

This segment of Temecula Creek was observed to be wide and heavily vegetated in parts; however, the main portion of the Creek that handles flows was deeply incised at points, with eight-to-nine-foot vertical cuts, soft banks, and a sandy bed. The historical aerials below (Figures 4-6 to 4-11) demonstrate how the channel planform has changed since 1995, and particularly show how concentrated flow has affected the channel form. Field photographs from September 14, 2017 (Figures 4-12 to 4-15) provide documentation of current conditions within the channel.

Figure 4-6 shows Temecula Creek upstream of Pechanga Parkway in late 1995. Per historical aerials, development of the Redhawk community was partially complete by this point, and development of a small residential neighborhood on Temecula Parkway between Country Glen Way and Avenida De Missiones was complete (partially shown in the top-right corner of Figure 4-6). The majority of the remainder of the upstream watershed was not yet developed, though some grading along the north bank of the Creek had begun.

The yellow arrow on the left side of Figure 4-6 shows a drainage lateral to the Creek. Subsequent aerial photos show the lateral enlarging and the effect on Temecula Creek is noticeable. For example, Figure 4-9 shows the Creek in January 2006, after this storm drain channel appears to have been completed. The Creek bed has widened substantially at this confluence and threatens the integrity of the adjacent parking lot. This area is circled in yellow on the left of Figures 4-6 to 4-11.

The yellow circle in the middle of Figure 4-6 shows Creek adjustment near a park on the south bank. This geomorphic adjustment appears to threaten to the structural integrity of the adjacent park.

The yellow arrow on the right side of Figure 4-6 shows the concentrated flow path for upstream flows in the Creek, including flows coming from the Country Glen Way development. Over time, as demonstrated in subsequent aerial photos, the flow path in this portion of Temecula Creek has adjusted. The Creek at this point becomes incised, with eroded vertical banks along the southern bank of the Creek. In addition, the southern bank of the Creek grows wider over time, and gets nearer and nearer to Strawberry Tree Lane.

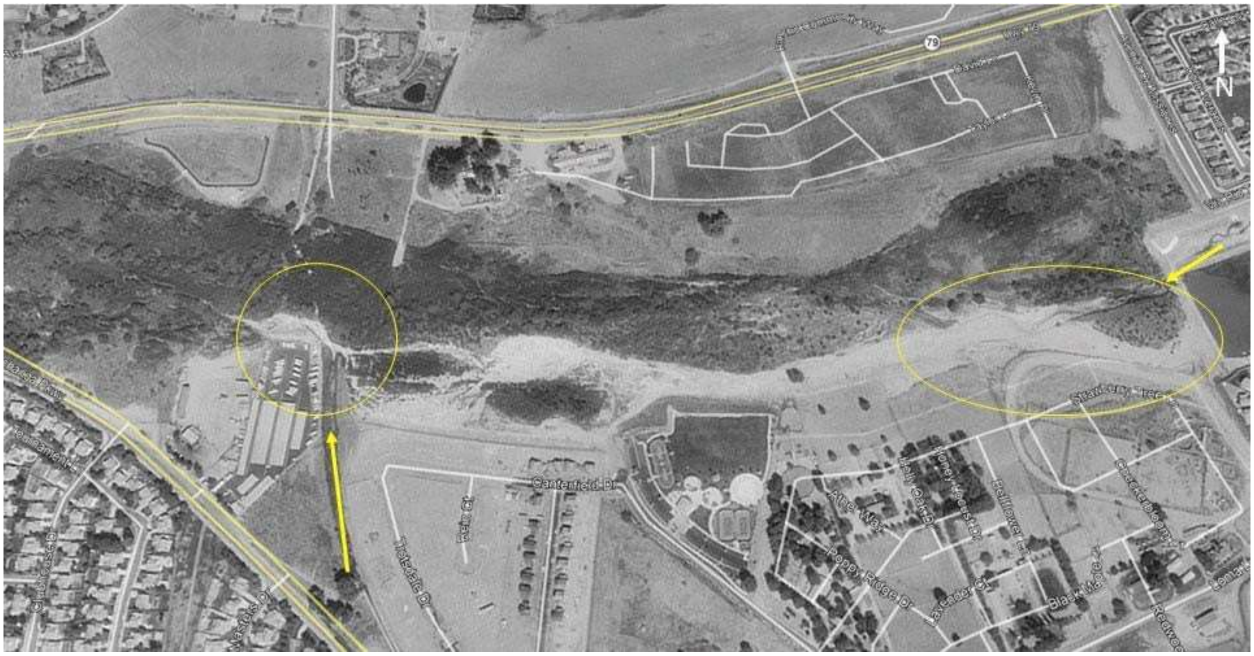


Figure 4-8. Temecula Creek at Pechanga Parkway, October 1995

Figure 4-9. Temecula Creek at Pechanga Parkway, October 2003

Figure 4-10. Temecula Creek at Pechanga Parkway, July 2004

Figure 4-11. Temecula Creek at Pechanga Parkway, January 2006

Figure 4-12. Temecula Creek at Pechanga Parkway, June 2012

Figure 4-13. Temecula Creek at Pechanga Parkway, October 2016

Figure 4-14. Temecula Creek at Pechanga Parkway, September 2017. Vertical cut along the north bank of the Creek

Figure 4-15. Temecula Creek at Pechanga Parkway, September 2017. Vertical cut along the south bank of the Creek

Figure 4-16. Temecula Creek at Pechanga Parkway, September 2017. Vertical cuts along the south bank of the Creek, adjacent to Pala Community Park

Figure 4-17. Temecula Creek at Pechanga Parkway, September 2017. Vertical cuts along the north bank of the Creek. Exposed tree roots shown

4.4.2 Recommendation

Based on the historical aerial photo review and field investigation conducted by Geosyntec staff, the downstream end of Temecula Creek is susceptible to erosion. Aerial photographs demonstrate a widening of flow path over the past 20 years. The field investigation observed soft, unconsolidated sand bed material and eroded channel banks, some of which threaten the physical integrity of infrastructure along the southern bank between Pechanga Parkway, at the downstream end, and Via Del Coronado, at the upstream end (e.g., parking lot, park with soccer field, and Strawberry Tree Lane). (Note: The calculations described in Section 4.2 only apply to channels that are stable in present condition; therefore, no calculations are provided for this reach of Temecula Creek being analyzed.)

In light of the creek's susceptibility to erosion and existing infrastructure concerns associated with geomorphic adjustment, it is recommended that the hydromodification exemption not be reinstated at this time. Temecula Creek can be considered a potential candidate for an in-stream restoration/stabilization project to remedy current stability issues and manage for future hydromodification effects associated with new development in its tributary watershed.

4.4.3 Murrieta Creek

The extents of the Murrieta Creek (Upstream Limit: 850 feet upstream of Hawthorn Street; Downstream Limit: Confluence with Santa Margarita River) for which hydromodification assessment is performed is shown in Figure 4-16. Section 4.5.1 presents an overview of the Murrieta Creek Flood Control, Environmental Restoration and Recreation Project.

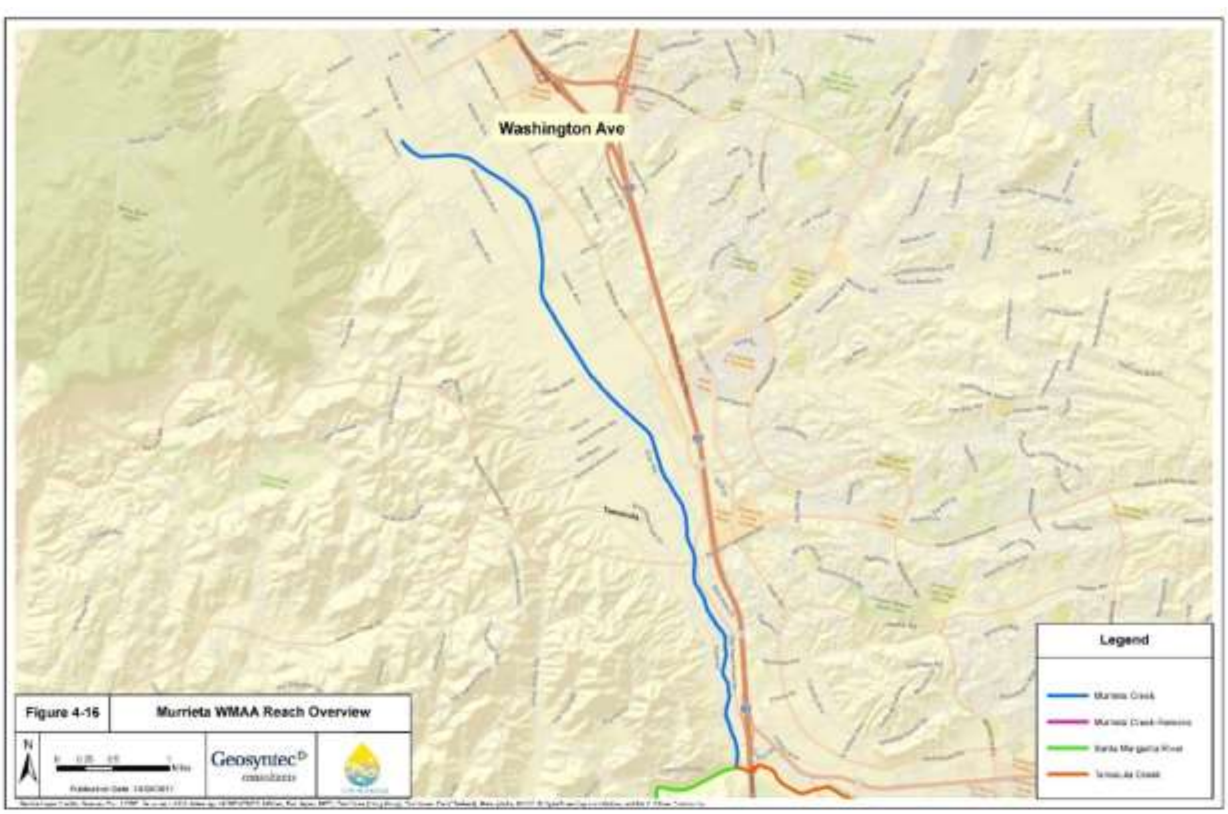


Figure 4-18: Murrieta WMAA Reach Overview

4.4.4 Murrieta Creek Flood Control, Environmental Restoration and Recreation Project

Murrieta Creek traverses the cities of Temecula and Murrieta in the densely populated southwest region of Riverside County. At the confluence with Temecula Creek, it forms the Santa Margarita River which flows through Camp Pendleton Marine Base and on to the Pacific Ocean. As a result of repeated flood events, culminating with the catastrophic flood in 1993, the U.S. Army Corps of Engineers initiated a study on a 7.5-mile section of the creek, which led to the 2000 Congressional recognition of the 4-phase Murrieta Creek Flood Control, Environmental Restoration and Recreation Project.

The project is anticipated to:

- Improve flood control and storm water retention
- Enhance water conservation and supply
- Provide recreation-related opportunities along the Santa Margarita River and its tributaries in Riverside and San Diego counties

Flood Control Features include:

- Widening and deepening of Murrieta Creek from the USGS stream gauge in Temecula to Tenaja Road in Murrieta
- A flood control detention basin occupying approximately 250 acres on the eastern side of Murrieta Creek between Santa Gertrudis Channel to approximately 500 feet upstream of the confluence with Warm Springs Creek and bordering Adams Avenue, Cherry Street and Jefferson Avenue
- Stream bank protection features between Rancho California Road and First Street

Locally Funded Recreation Features include:

- Construction of a public park of about 50 acres in size within the easternmost portion of the detention basin. This will include parking lot, children's play area, shade structures, comfort station, barbecues, open space, walks, baseball and soccer fields, security lighting, pedestrian/bicycle/equestrian bridges spanning Santa Gertrudis Creek and Murrieta Creek
- Bicycle and equestrian/hiking trails along the eastern and western park in the detention basin, with undercrossing structures beneath the bridges on First Street, Rancho California Road, Winchester Road, Guava Street and Ivy Street

Environmental Restoration Features include:

- Constructing a low flow channel with natural backwaters
- Creating a transitional wetland habitat from freshwater marsh habitat to willow riparian woodland with an upland buffer of mulefat scrub and coastal sage scrub within a 163 acre site
- A 13.7 acre sediment catchment area at the confluence of Murrieta and Warm Springs Creeks

The four phases of the project are shown in Figure 4-17. Phase 1 construction is complete. Phase 2 construction is anticipated to be complete by January 2018. Typical existing and proposed cross section for phase 2 is shown in Figure 4-18.

Figure 4-19. Murrieta Creek Flood Control, Environmental Restoration and Recreation Project

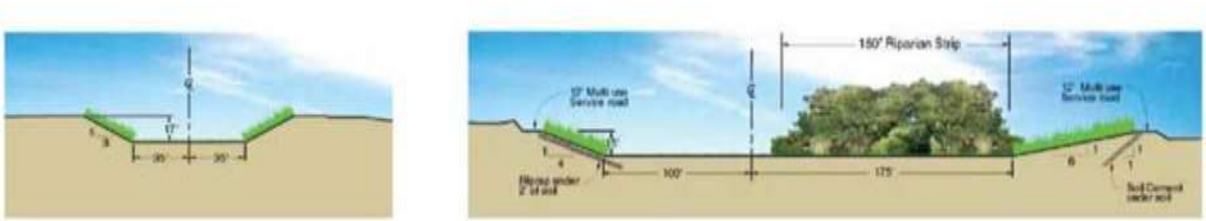


Figure 4-20. Typical existing and proposed cross section for Phase 2

Based on the field visit and assessment conducted by Geosyntec staff on September 14, 2017 the existing phase 3 reach is stable (see Figure 4-19). In the Phase 4 area, walking from downstream to upstream the first sign of erosion was observed at around 80 feet upstream of Washington Avenue (see Figure 4-20).

Figure 4-21. Looking downstream near the Murrieta Creek and Santa Gertrude Creek confluence. Heavily vegetated channel bed and concrete side slope.

Figure 4-22. Looking towards east riverbank 80 feet upstream of Washington Avenue overpass. Sandy gravel riverbanks showing a 25 foot high erosion cut.

Based on the findings from the field visit and consideration of the ongoing Phase 2 of the Murrieta Creek Flood Control, Environmental Restoration and Recreation Project that is anticipated to be complete by

January 2018, the exemption analysis extents were revised for Murrieta Creek (Upstream Limit: Washington Avenue; Downstream Limit: Confluence with Santa Margarita River). The same approach that was used for Forester Creek (engineered channels that are stabilized with materials other than concrete, such as riprap, turf reinforcement mat, or vegetation) as part of the San Diego River WQIP was implemented for Murrieta Creek and summarized below.

4.4.5 Erosion Potential Analysis

See section 4.2.1 for a description of the entire erosion potential analysis. This section includes specific information on erosion potential in the extents of the Murrieta Creek:

The following steps were implemented to estimate the Erosion Potential:

- The table below presents the input parameters used to construct flow histograms. The critical slope and cross-section was obtained from Phase 2 design plans.

Stabilized Conveyance System	Area below the reservoirs/lakes (sq. miles)	Mean Annual Precipitation (in)	Length of Daily Flow Record (Years)	Channel Slope (ft/ft)
Murrieta Creek	149	14.7	30	0.002

- The critical cross section was based on the narrowest cross section (140 feet wide trapezoidal channel) and the steepest slope (0.2% longitudinal slope) in the phase 2 plans.
- Critical shear stress was estimated to be greater than or equal to 1.2 pounds per square foot (lb/ft2), based on review of permissible shear stress values presented in "Stability Thresholds for Stream Restoration Materials" (Fischenich 2001) and "Streambank Soil Bioengineering Considerations for Semi-Arid Climates" (Hoag and Fripp 2005). Based on Fischenich 2001, permissible shear stress for "long native grasses" is approximately 1.2 to 1.7 lb/ft2. The side slopes are generally either turn reinforcement mat, soil cement protection, rip-rap or dense vegetation all of which have critical shear stress greater than or equal to 8 pounds per square foot (lb/ft2)

Steps 1 to 5 were performed in Excel. Ep estimates for the exempt river reaches are included as an Attachment H. Results from the Ep analysis are summarized in table below.

Stabilized Conveyance System	Area below the reservoirs (Skinner Reservoir) (acres)	Impervious Area (acres) [%]			Ep (Post/Pre)
		Pre (existing)	Post (built out)	Increase	
Murrieta Creek	95,251	13,762 [14.4]	20,634 [21.7]	6872 [7.3]	1

The analysis results, presented in Attachment H, show that for both the existing and future condition, the shear stress for all geomorphically-effective flows is less than the estimated critical shear stress of 1.2 lb/ft^2. This means that no excess shear stress or "work" occurs in the channel in either the existing or future condition. Therefore, there is no increase in the duration of "work" (cumulative work), in the future condition, and erosion potential is 1.0.

Note that while the flow rates are the same in both the existing and future condition analyses, the duration of each flow rate is increased in the future condition. The flow rates in the flow bins are based on the watershed area, mean annual precipitation, and length of the synthetic record. The synthetic record means the modeled or analytically- derived series of hydrology parameters such as flow rate and duration of flow at points or nodes in the system. Available measures parameters such as precipitation, catchment area, catchment slopes, channel conditions, and are used as inputs to the model or algorithm. Watershed area, mean annual precipitation, and length of the synthetic record do not change from existing to future condition. The duration for each flow bin is related to the watershed area, mean annual precipitation, length of the synthetic record, and the impervious area. The duration increases in the future condition based on the increased impervious area. The increase in duration would result in increased cumulative work in the future condition if any of the flow rates resulted in shear stress greater than the estimated critical shear stress (excess shear stress, or "work"), because cumulative work is the product of work times duration.

The scenario that occurred in the Murrieta Creek analysis, in which no work occurred in the expected range of geomorphically-effective flow rates, is a potential scenario for engineered channels because engineered conveyance systems are typically engineered for flood flows much greater and less frequent than the geomorphically-effective flows. For example, Murrieta Creek is being engineered to convey a 100-year flow rate of approximately 30,900 cubic feet per second (cfs) (100-year flow estimate is from FEMA Flood Insurance Study). The maximum geomorphically-effective flow rate for Murrieta Creek is 11,000 cfs.

In addition, the USACE report states that for the Phase 2 design it is anticipated that flows of about seven feet/second and above could cause erosion and scouring of the unmaintained riparian/low-flow corridor. These occurrences of erosion and scour are expected to be within the range of current conditions. It is anticipated that the larger trees would remain in place once established; however, the smaller trees and shrubs may be washed out during significant storm events. Natural recruitment is expected within areas of scour as has occurred within the Phase I area, where riparian and wetland vegetation within the channel invert has re-established after completion of construction. The estimated velocity for the maximum geomorphically-effective flow rate of 11,000 cfs for Murrieta Creek is 5.8 feet/second. This also supports the hydromodification management exemption.

4.4.6 Recommendation

Based on the results from this study, it is recommended that hydromodification management exemption be reinstated for projects discharging runoff directly to the Murrieta Creek (Upstream Limit: Washington Avenue; Downstream Limit: Confluence with Santa Margarita River).

Hydromodification management exemption from Washington Avenue to 850 feet upstream of Hawthorn Street is not reinstated at this time. Based on the field visit and assessment by Geosyntec staff, this segment of channel appeared to be unstable and susceptible to erosion.

4.5 Conclusion

Based on the results from this study, it is recommended that hydromodification management exemption be reinstated for projects discharging runoff directly to the following exempt river reaches:

- Santa Margarita River

    - Upstream Limit: At Origin, i.e. Confluence with Temecula Creek and Murrieta Creek
    - Downstream Limit: Outfall to Pacific Ocean
- Murrieta Creek
    - Upstream Limit: Washington Avenue
    - Downstream Limit: Confluence with Santa Margarita River

Each municipality must define/approve "direct discharge" based on the project site conditions. To qualify for the potential exemption, the outlet elevation must be between the river bottom elevation and the 100-year floodplain elevation and properly designed energy dissipation must be provided.

4.5.1 Factors of Safety

The analysis conducted to evaluate the applicability of hydromodification management requirements to priority development projects directly discharging to the exempt river reaches have the following implicit factors of safety:

- The analysis assumes all projects within the watershed will be exempt from hydromodification management requirements for erosion potential and coarse sediment supply calculations (note: during actual implementation only projects directly discharging to the exempt reach will be exempt). This conservative assumption provides an implicit (non-quantified) factor of safety.
- The analysis assumes all impervious area in the watershed is directly connected impervious area. In actuality, some portion of these impervious areas will sheet flow through pervious areas prior to discharging to the streams. This dispersion will result in attenuation of flow rates and durations that are not accounted for when estimating the sediment transport capacity of the built-out condition. This conservative assumption provides an implicit (non-quantified) factor of safety.
- New priority development projects, including projects that are proposed to be exempt from hydromodification management requirements through this study, must implement retention BMPs to the extent feasible if participation in alternative compliance is not selected or allowed. This requirement will result in attenuation of flow rates and durations that are not accounted for when estimating the sediment transport capacity of the built-out condition. This conservative assumption provides an implicit (non-quantified) factor of safety.
- Redevelopment priority development projects in the watershed that do not directly discharge to the river reach that is exempt by this study must mitigate flows to the pre-developed condition. This will result in over mitigation of flow rates and durations for redevelopment projects which are not accounted for when estimating the sediment transport capacity of the built-out condition. This conservative assumption provides an implicit (non-quantified) factor of safety.

4.5.2 Limitations

The analysis and associated recommendations as presented above were based on instream erosion as the primary consideration to support reinstatement of exemptions from hydromodification management controls for discharges directly to these river reaches. While it is recognized that other factors contribute to adverse impacts (e.g., salinity imbalance, pollutants) to instream habitat and resulting biotic integrity, hydromodification management control has traditionally been considered an "umbrella process" that encompasses most of the highest risk stressors (percent sands and fines present, channel alteration, and riparian disturbance) to physical habitat.

The current assessment methods may yield inconclusive results when attempting to identify causal relationships between degraded instream habitat solely due to increased flows and erosive force from hydromodification. A causal assessment recently conducted in the lower reaches of the San Diego River, conducted as a partnership between the Southern California Coastal Water Research Project (SCCWRP), the City of San Diego, the County of San Diego, and the San Diego RWQCB, focused on stressors potentially responsible for known biological impairment of the river. Once the data of the causal assessment become available, it may be useful in classifying the potential stressors such as altered physical habitat as likely, unlikely, or an uncertain cause to biological impairment.

With respect to adverse impacts to habitat as a result of pollutants entrained in storm water discharges, these areas will still be subject to the pollutant control requirements of the Regional MS4 Permit as areas develop or redevelop. The current requirements require development to maximize retention of the design storm volume which will mitigate a portion of the volume that would otherwise be controlled with hydromodification management BMPs. In some cases, this offsetting of volume reduction through pollutant control BMPs may exceed the HMP volumes. In addition, the development that occurs within the exempted watershed areas is still required to provide any applicable flood control measures. Risk of flooding as a result of exemption from hydromodification controls is unlikely as the control thresholds are significantly lower (order of magnitude) than flood control requirements implemented to protect life and property.

5 Conclusions

This WMAA used available regional data to understand watershed-scale characteristics and processes in the SMR. The results of this analysis are shown on the maps in Attachment A. This analysis combined with the San Diego Water Quality Equivalency guidance can be used to provide flexibility with meeting the Permit's land development requirements. The WMAA mapping includes readily available regional datasets and specific projects will be augmented with site-specific analysis. As such, projects will also consult the future BMP Design manual for options to meet the Permit requirements. The Co-Permittees continue to develop the BMP Manual and are looking for additional compliance options for small projects, single-family residences or sites that substantially mimic predevelopment conditions.

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7 Glossary

Term	Definition
Alternative Compliance Program	An optional program that may be implemented by individual Co-Permittees to allow for offsite ACPs to offset stormwater pollutant control and hydromodification impacts that are not fully addressed at PDP sites.
Best Management Practice (BMP)	Any procedure or device designed to minimize the quantity of Pollutants that enter the MS4 or to control stormwater flow.
Bioretention	A type of BMP that is designed to capture a certain volume of stormwater within a biologically active soil media. Retained water is evapotranspired by plants in the BMP or allowed to slowly infiltrate into the underlying soils.
Hydromodification	The change in the natural watershed hydrologic processes and runoff characteristics (i.e., interception, infiltration, overland flow, and groundwater flow) caused by urbanization or other land use changes that result in increased stream flows and sediment transport. In addition, alteration of stream and river channels, such as stream channelization, concrete lining, installation of dams and water impoundments, and excessive streambank and shoreline erosion are also considered hydromodification, due to their disruption of natural watershed hydrologic processes.
Municipal Separate Storm Sewer System (MS4)	A conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, manmade channels or storm drains) as defined in 40 CFR 122.26(b)(8).
Priority Development Project	New development and redevelopment projects defined under Provision E.3.b of the Permit.
Structural BMP	A subset of BMPs which detains, retains, filters, removes, or prevents the release of pollutants to surface waters from development projects in perpetuity, after construction of a project is completed.
Water Quality Improvement Plan (WQIP)	A planning document which describes programs which will be implemented to meet water quality requirements as described in Provision B of the Permit.
Water Quality Equivalency	Methodologies and calculations used to determine water quality benefits and water quality impacts, and to apply them toward the design, review, and approval of PDPs and ACPs in meeting the Section E.3.c.(3) requirements of the Permit.
SMR Co-Permittees	The SMR Co-Permittees include County of Riverside, Riverside County Flood Control and Water Conservation District, City of Wildomar, City of Murrieta, City of Temecula, City of Menifee and County of San Diego.

Attachments